Engineering Library

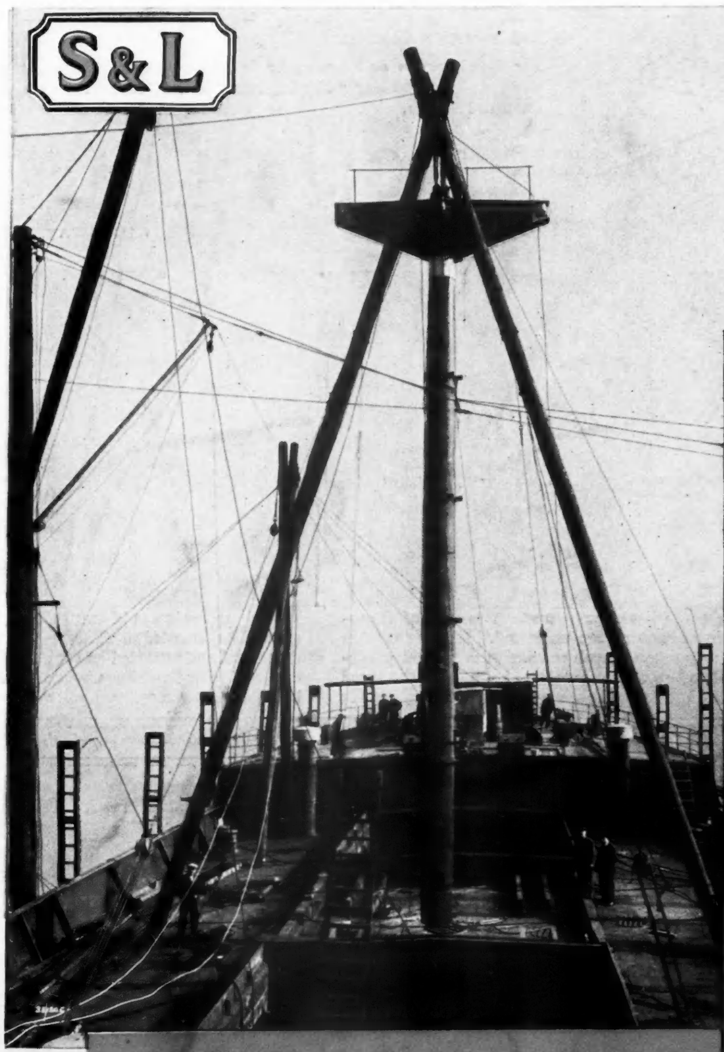
Printed on thin paper for overseas circulation.

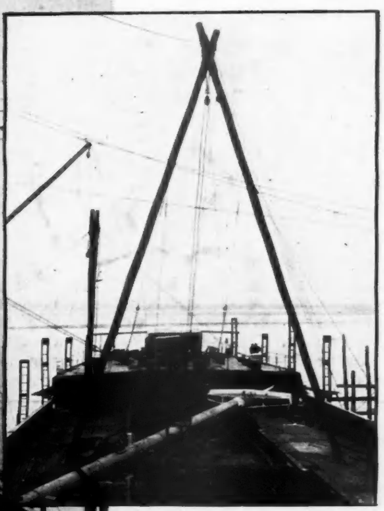
OCT 16 1939

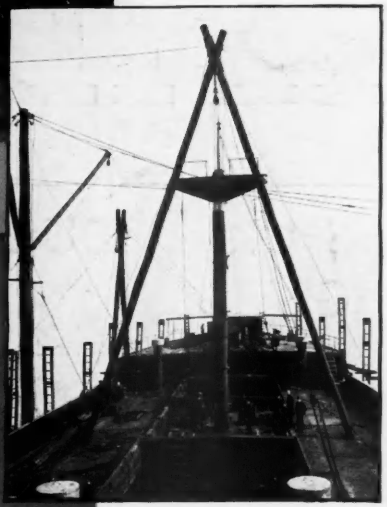
The Engineer

Vol. CLXVIII.—No. 4367 28, ESSEX ST., STRAND, LONDON, W.C. 2 SEPTEMBER 22, 1939

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper







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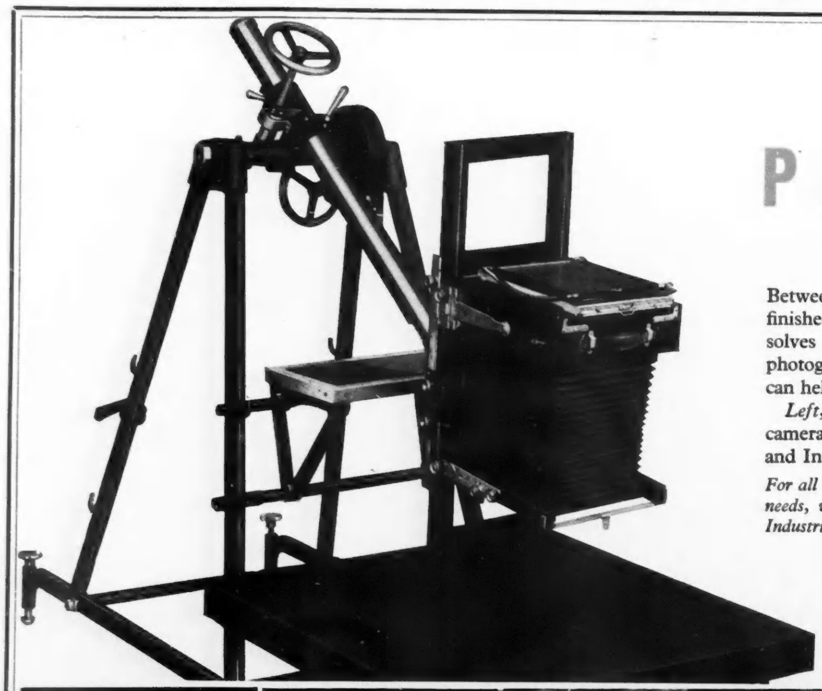

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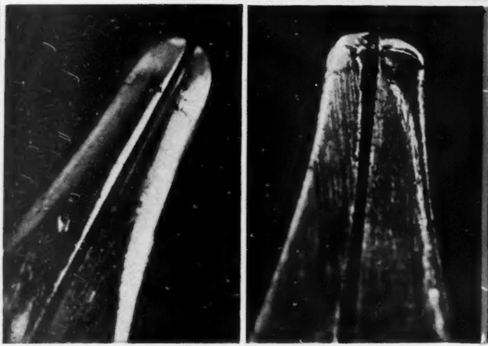
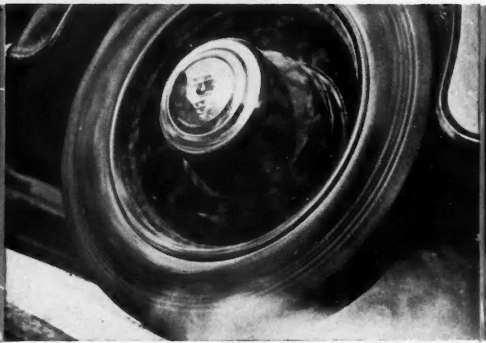


Nothing escapes Photomicrography. Photography through the microscope lens reveals, as nothing else can, facts about materials or product. Here effectively used for Publicity. (Left) Parker nib point; (right) ordinary nib point. (Courtesy of Parker Pen Co., Ltd.)



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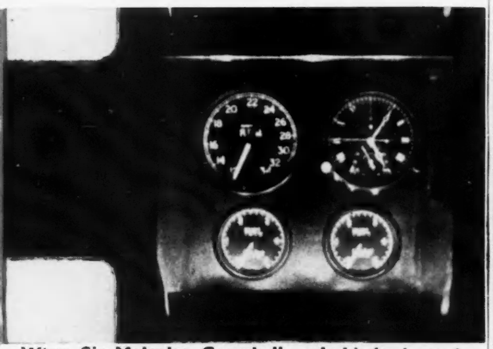

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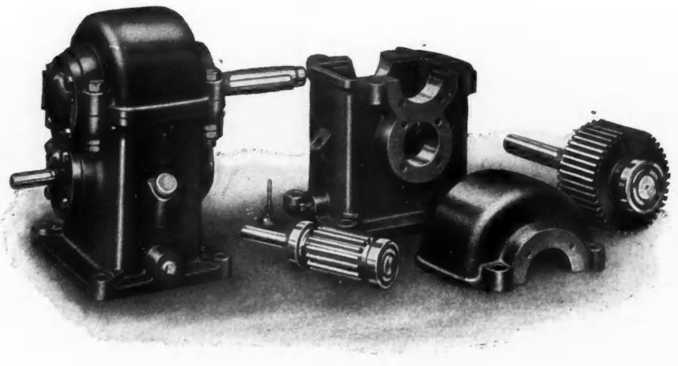

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A Seven-Day Journal

The Loss of H.M.S. "Courageous"

ON Monday afternoon, September 18th, it was officially announced that H.M.S. "Courageous," one of our larger aircraft carriers, had been torpedoed and sunk by a German submarine. The attacking submarine was herself, it is reported, heavily attacked by British destroyers and is believed to have been sunk. The survivors were rescued by destroyers and merchant ships, and were brought back to harbour. The "Courageous" was, it may be recalled, one of our earliest aircraft-carriers. She was originally a cruiser and was laid down in May, 1915 at Armstrongs' yard on the Tyne, and was designed for shallow water, having a length of 735ft. between perpendiculars, a beam of 81ft. 3in. over bulges, and a mean draught of 22ft. 2in. Her propelling machinery comprised a quadruple screw arrangement of Parson's geared turbines taking steam from 18 Yarrow small tube boilers, giving her a designed output of 90,000 S.H.P. and a speed of about 30 knots. In June 1924 she was taken in hand by Devonport Dockyard for conversion to an aircraft carrier, and a flight deck 100ft. in width was provided. In 1936 she was completely refitted and a light tripod mast was added to her superstructure. She was well armoured and carried sixteen 4·7in. high- or low-angle guns, four three-pounders and seventeen smaller guns. Her official complement of aircraft was 48 machines. The normal complement of the ship was 1216 persons which included 468 flying personnel. In August she was requisitioned with the Reserve Fleet with a reduced complement of aircraft, and since the opening of hostilities she has been performing excellent service in protecting ships of the mercantile marine against submarine attack.

A Ministry of Shipping

IN the course of a speech made in the House of Commons on Wednesday, September 13th, the Prime Minister, Mr. Neville Chamberlain, said that it was the intention of the Government to establish a Ministry of Shipping at an early date. Plans for such a Ministry had, he said, been in existence for some time past. At the moment, however, Mr. Chamberlain said, when the organisation to deal with shipping was being expanded very rapidly, there was much to be gained in efficiency, by retaining the organisation for a further period within the Board of Trade. In constructing any new machine to deal with shipping matters, there would always be the legal, technical and administrative experience of the Board of Trade to draw upon. At the time there was a considerable process of expansion being carried on, which he thought might take a week or two longer, and while that expansion was proceeding he thought it was better to keep the machinery in the Board of Trade. With regard to the present position, an assurance was given by Mr. R. H. Cross, the Minister of Economic Warfare, that vigorous measures were already in operation in order to prevent such commodities as tin, rubber and cotton from reaching the enemy either by land or by sea. He recalled that in the last war, the Ministry of Shipping was not formed until the end of 1916. That Ministry was under a shipping controller and had the status of a separate department with representation in the Cabinet. The Board of Trade formed the nucleus of that scheme. It would be recalled, Mr. Cross went on to say, that early in 1917 the work of the Ministry of Shipping was greatly enlarged by the decision upon universal requisition, and the liner companies and their organisations were used, and other branches of the Ministry were formed as required. By the middle of 1917 the Ministry had proved to be one of the most successful of the many departments formed during the war. A further announcement with regard to the formation of the proposed new Ministry and the appointment of a controller of shipping is expected to be made before very long.

The Inspectors of Explosives Report

THE sixty-third annual report of His Majesty's Inspectors of Explosives has been issued by the Stationery Office. Under the Explosive Act the report deals with the working of the Explosive Acts during the year ended December 31st, 1938. It comprises three sections dealing with explosives, petroleum and miscellaneous subjects, and detailed information concerning the accidents which have occurred are contained in the report. Local Authorities are urged to obtain these Reports regularly, as responsibility rests upon them to do so for the more efficient exercise of their powers under the Explosive Acts and the Petroleum Acts. The inspection work has, the Report states, again suffered severely on account of urgent work in other directions, in particular that of the Air Raid Precautions Department. The Chief Inspector, Lieut.-Col. R. A. Thomas, has for some years been chairman of three Experimental Committees covering bombing tests with high explosive bombs, safety precautions for oil depots, and methods of controlling incendiary bombs. Following the sanction of an increase in the number of Inspectors of Explosives, Major W. Crawford, of the Royal Arsenal and the War Office, has been selected for appointment as an additional Inspector, and took up his work early in March, 1939. Two accidents receive special mention in the report, they are the explosion in an Atlas mixer at Nobel's Explosive Company's Ardeer factory, and the explosion and fire which occurred at the Brtish Oxygen Company's Jarrow factory in the acetylene compressing section. Accidents have occurred with disused explosives, and the attention of Local Authorities is drawn to the necessity for assisting the public against the danger from disused explosives stores. Warning is again given against the dangers of chlorate sulphur mixtures or chlorate and phosphorous mixtures, from which serious accidents have occurred. The emergency conditions of September, 1938 cause, the Report states, a revival of interest in the problems connected with the gas traction question. Owners of lorries, &c., anticipating the inevitable restriction of petrol supplies, began to think of possible substitutes of which compressed town's gas is one. It is to be hoped, the Report says, that the revived interest in this, one of several home produced substitutes for petroleum spirit, will not be allowed to die. A reliable and, at the same time, not expensive design of gas cylinder, would assist the project.

War Risks Insurance

ACCORDING to a Board of Trade announcement, certain apprehensions have been expressed by traders with regard to the operation of the War Risks Insurance Act, 1939. There have been complaints that the rate of premium is too high. We are informed that the rate had to be fixed, in the absence of any actuarial data, on the basis of certain assumptions. It will be reconsidered in the light of experience, and, if circumstances so permit, it can be reduced at the end of the three-monthly period, or the period of insurance may be extended without the payment of additional premium. Furthermore, it has come to the notice of the Board of Trade that registrations were effected before the outbreak of war for amounts greater than those for which insurance was eventually required. It has, therefore, been arranged that traders will be permitted to pay the premium appropriate to the value of the stocks actually held by them on the outbreak of war. Since the stocks of traders may fluctuate over the three-monthly period during which a policy of insurance is current, arrangements are being made for the premiums to be adjusted so that traders will not be required to pay a premium on amounts greater than the value of the stocks actually held from time to time during the period of insurance. Full instructions will, as soon as possible, be sent to the agents of the Board of Trade for their guidance in dealing with applications. A number of applications which have been made by responsible bodies requesting the exemption from the scope of the commodity insurance scheme of certain goods on the ground of indestructibility or unsaleability are receiving urgent consideration, and decisions will be announced at an early date. It will be recalled that the rate of premium has been fixed at 10s. per £100 a month for three months from September 3rd.

Ministry of Economic Warfare

FURTHER to our Journal note of last week, recording the setting up of a Ministry of Economic Warfare, it is officially announced that Sir Frederick W. Leith-Ross, who is the Chief Economic Adviser to the Government, has been appointed to be Director General of the Ministry, and that Sir George Augustus Mounsey, Assistant Under-Secretary at the Foreign Office, has been appointed to be Secretary to the Ministry. Sir Frederick Leith-Ross, who has held the office of Chief Economic Adviser to the Government since 1932, had a brilliant career at Oxford, and entered the Treasury in 1909, where in 1925 he became Deputy Controller of Finance. He was the British representative on the Finance Board of the Reparation Commission, principal financial expert at the Hague conferences, and a member of the British delegation at the World Economic Conference which was held in 1933. Sir Frederick has negotiated financial agreements between Britain and several foreign powers, and is a member of the Economic Committee of the League of Nations. An announcement made by the Ministry of Information on Monday, September 18th, states that among the contraband consigned to Germany which has been seized during the week ending Sept. 9th, were cargoes of petroleum amounting to 28,500 tons. During the same period other cargoes which were intended for Germany and which were intercepted at the various contraband examination bases, were large quantities of iron ore, manganese ore, wood pulp and phosphate. Until the Prize Court in London begins its sittings, which are expected very soon, the intercepted cargoes remain under the jurisdiction of the Admiralty Marshal, who has the power to direct them to be sold. The value of the cargoes and the question of costs and expenses, are all settled by the order of the Prize Court which will apply to these cases the recognised and established rules of international law.

Economy in the Use of Electricity

UNDER the order made by the Mines Department, the consumption of coal, gas and electricity by domestic and other small users must not exceed 75 per cent. of their consumption in the year ended June 30th last, except that every householder is entitled to at least two tons of coal, including boiler coke, 200 units of electricity and 100 therms of gas. These amounts will be sufficient for the small house. Where electricity is used for cooking the allowance is 1000 units. Hints on how to make the most of rationed fuel supplies and how best to economise in fuel consumption were given last week by the British Electrical Development Association. The simplest and most effective way of reducing current consumption, it is explained, is to be economical in the use of electric fires, which are heavy users of electricity. Most of them have two heating elements, and as soon as a room becomes warm one or both should be turned off. One bar of a radiator may consume more electricity than all the lighting in a house. As lamps consume little electricity it is better to screen all windows than endure a depressing gloom indoors. Blue glass or black paper shades are useful for halls and passages, but for living rooms and kitchens it is more economical and satisfactory to retain the usual lamp shades and to reduce the consumption of electricity by using 60 watt instead of 100 watt and 40 watt instead of 60 watt lamps. The average consumption of refrigerators is less than a unit a day, and to economise in the amount of electricity used, as little ice as possible should be taken from the trays, because ice making accounts for a large part of the consumption of electricity. Advice is also given on the use of electric cookers, kettles, vacuum cleaners, etc. Finally, consumers of electricity are advised to check their meters, and the British Electrical Development Association of 2, Savoy Hill, W.C.2, will be pleased to advise anyone in the case of difficulty.

Petrol Rationing and Tax Yield

IN a letter which has been sent by the Royal Automobile Club to the Secretary of the Department of Mines, a strong protest is made against the rationing of petrol, which we may recall has now been delayed for a further week. The Club maintains that the rationing proposed will have the effect of reducing the mileage which may be covered, to one-tenth in the case of many cars, one-quarter in the majority of cases, and even at the best, in cases where a car is used only occasionally, to one-half. It is pointed out in the letter, that such a reduction of mileage can only have two results. Firstly, business and commerce will be interfered with to a degree that it is impossible to estimate, and secondly, the estimate of £100,000,000 of revenue, from motor taxation generally, including the yield from the fuel tax made by the Chancellor of the Exchequer in his Budget statement of April last, will prove to be entirely illusory. Further, it is maintained that the retail section of the motor industry will be brought to the verge of bankruptcy by the disappearance of a very large proportion of its trade. It is submitted that some review of the position as far as the petrol-rationing scheme is concerned, is most urgent. It is suggested by the Royal Automobile Club that as an experiment the quantity at present allocated should be doubled, without interfering with the present right of appeal for an increase in this supply, in circumstances where such an increase is essential. Such a concession would, it is contended, remove a little of the hardship so far as business and commerce is concerned, and it would at the same time encourage all motorists to continue to use their cars, even to a limited extent, and so serve to maintain the national revenue at the highest possible level. The Club further asserts that there are at present certain anomalies in the scale of supplies which deserve consideration. The flat rate of 10 gallons of petrol for all cars of 20 H.P. and over operates, it is contended, harshly, and the Club makes the suggestion that cars over 20 H.P. and up to 25 H.P. should receive 12 units per month, and those over 25 H.P. 15 units a month. The allowance for motor cycles, it holds, should be based on the engine capacity basis, the flat rate of two units a month operating most unfairly on machines with engines over 250 cc. Allowance ought also to be made for a motor cycle with an attached side car. While fully alive to the need of restriction in the use of petrol in order to ensure adequate supplies for the fighting forces, and taking into account other factors, the Club nevertheless feels that the vital importance of transport to the commercial needs of the country renders some relaxation of the present rationing scheme essential.

A History of Rotary Engines and Pumps

PART II.—No. IX

(*Continued from page 272, Sept. 15th*)

CONCEALED RECIPROCATORS

THE early "Concealed Reciprocator" machines were nearly all designed as engines, and though a few of them survived for a number of years in that form, none achieved any permanent success. In the present century, however, machines of this kind have achieved a considerable degree of importance as hydraulic pumps and motors, particularly when linked together to form an hydraulic transmission gear unit. For that purpose they have the advantage, as will be seen later, that an arrangement can be quite easily effected to vary the speed of the output shaft over a wide range while the unit is actually running.

The "Boreas" machine, made by Lacy Hulbert and Co., Ltd., of Beddington, Croydon, since about 1906, is a straightforward pump that has been found especially suitable for thick liquids such as tar and crude oil, and for lifts up to 100ft. or so. The block or piston Y—Fig. 103—is caused to move, relatively, up and down a slot in the main rotor X owing to its linkage to a roller on a pin Z fixed excentrically in the pump cover. The arrangement is clearly that of Peck's machine of 1883, described in the first part of this series. Pumps are made in capacities from 500 to 2000 gallons per hour, and run at moderate speeds between 400 and 200 r.p.m. The main rotor is made in one with the driving shaft, and all parts are made of cast iron or gun-metal.

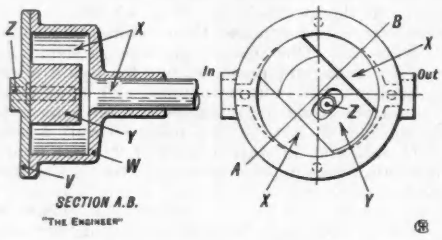

FIG. 103—BOREAS PUMP—LACY HULBERT

It is interesting to note that a somewhat similar machine was put into use in France by a M. Morin about 1913. In his machine, however, the piston, instead of having a slot to receive an excentric pin fixed to the end cover, was actually mounted on an excentric and the main rotor seems to have been left free to revolve under the action of the piston, which was carried round by the rotation of the excentric. That arrangement has the disadvantage that the angular velocity of the main rotor must be far from constant, so that undesirable inertia stresses may be set up. Similar stresses are, of course, present in the Lacy Hulbert machine owing to the variation in the movement of the piston, but since that member is relatively small and light they are very much less important.

The machine made to this day by the Rotoplunge Pump Company, Ltd., of Victoria Street, London, was invented by Mr. W. I. Vincent, of Cardiff, in 1910.

A drawing reproduced from THE ENGINEER of that year in Fig. 104 shows the arrangement originally adopted and the drawing reproduced in Fig. 105 represents a modern machine. It will be seen that the main rotor A has bored in it at right angles to each other and to the shaft two cylinders. Plungers B work in these cylinders and are shaped to engage with a square block C able to rotate on a stationary pin fixed in the end cover with its axis excentric to that of the shaft. As a result of the excentricity the plungers are caused to reciprocate as the shaft and rotor turn. In small pumps, such as the one illustrated, the main rotor is made in one with the shaft, but in larger machines they are separate parts.

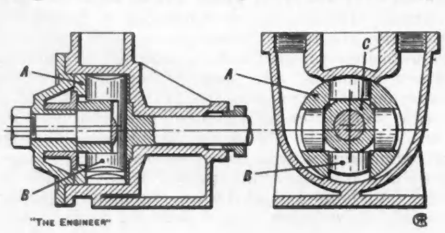

FIG. 104—ROTARY PUMP 1910—ROTOPLUNGE

If the rotation of such a machine is reversed it is clear that the flow of the fluid through the branches will also be reversed. But by transferring the excentricity of the pin through 180 deg. to the other side of the shaft the original direction of flow can be retained. The company makes a unidirectional, reversible pump of this kind, in which within the standard end cover there is an inner cover free to revolve through 180 deg. on change of direction of rotation. In a machine similarly arranged, but with an external handle controlling the situation of the inner cover, reversal of the flow through the branches can be simply brought about by the use of the handle. Such pumps find a particular use on motor tank wagons, where the driving shaft normally rotates always in the same direction. There are also made pumps in which, by means of a double excentric mechanism, the excentricity of the pin can be varied at will between zero and a maximum, thus providing for variable delivery at constant speed. By means of a suitable control mechanism a pump of that kind can be "governed" to maintain a constant pressure, the delivery being varied in accordance with the demand. A photograph reproduced in Fig. 106 shows a variable delivery constant pressure pump of the kind concerned. It has a maximum delivery of 12 tons per hour of fuel oil against 200 lb. per square inch pressure and is intended for supplying oil burners.

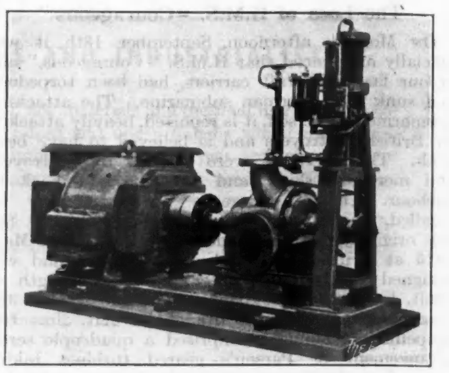

FIG. 106—ROTOPLUNGE OIL FUEL SERVICE SET

Pumps made by the Rotoplunge Pump Company, Ltd., are said to be suitable for all kinds of liquids, including petrol, water, printers' ink, molasses, tar, fuel oil, &c. The machines run at speeds up to 1000 r.p.m. and are made in a range of standard sizes with capacities up to 50,000 gallons per hour.

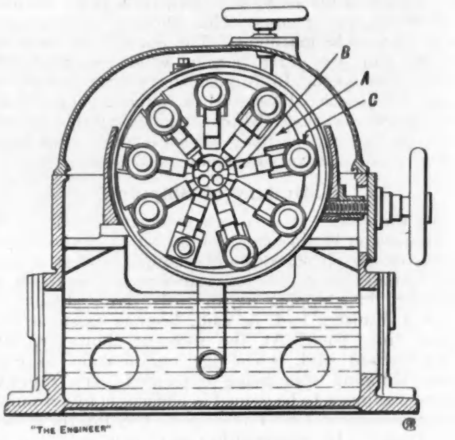

FIG. 107—ROTARY PUMP—PITTLER

A machine is made by Pittler Werkzeugmaschinenfabrik, of Leipzig, for which Dowding and Doll, Ltd., are agents in this country is illustrated in Fig. 107. A short cylindrical rotor A carries a number of small radial cylinders B. Pistons working in the cylinders are connected at their outer ends to rollers C, which work in an annular channel in a disc mounted freely alongside the cylinder block. Since the disc is mounted on an axis excentric to that of the cylinder block, the pistons are caused to reciprocate. The shaft in the centre of the block is stationary and is bored with suction and discharge passages. Two such devices are mounted at opposite ends of a common stationary shaft. One of them is driven by an external electric motor and its delivery is fed to

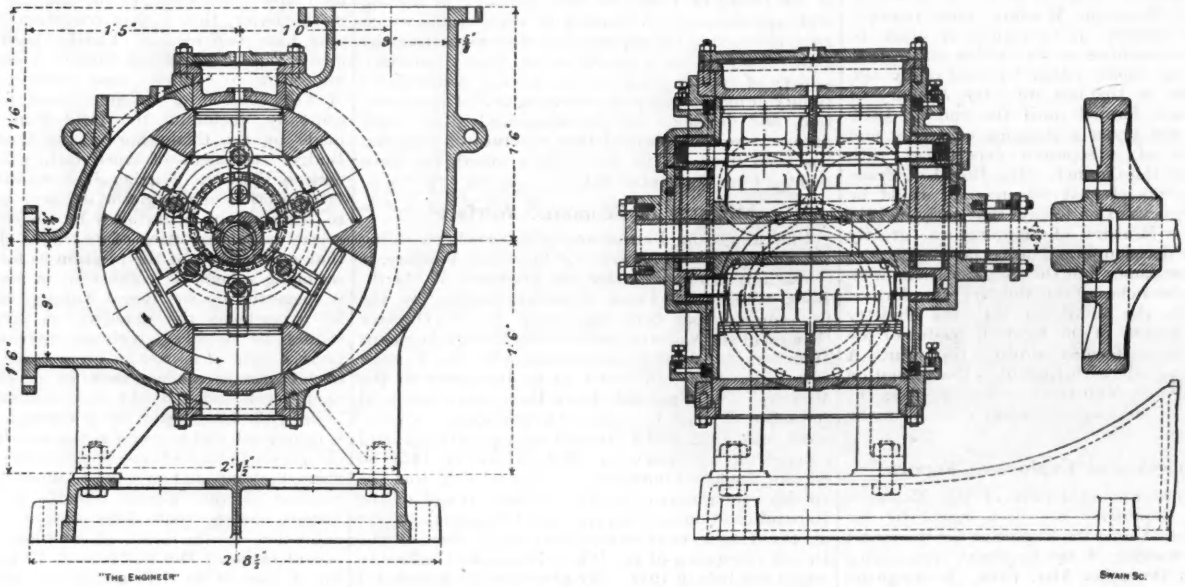

FIG. 105—SECTIONS THROUGH MODERN PUMP—ROTOPLUNGE

the second, which thus acts as an hydraulic motor. The machine which acts as a pump, is fitted with an external hand wheel by the use of which the excentricity of the excentric disc can be altered at will between zero and a maximum while the machine is running. The stroke of the pump pistons is thus altered, resulting in a variation in the output of the pump, and consequently of the speed of rotation of the hydraulic motor to which it is linked. The whole of the mechanism is enclosed in a casing the base of which acts as a reservoir for oil in circulation between the pump and the motor.

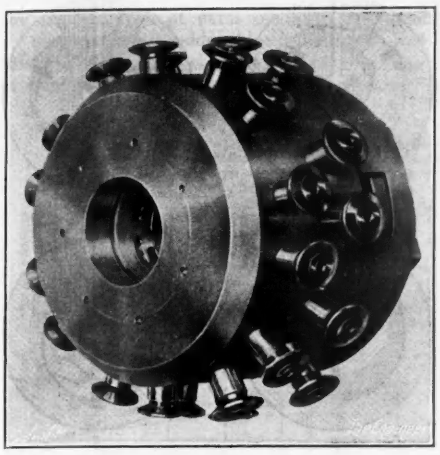

FIG. 108—CYLINDER ASSEMBLY—WEATHERLY

An infinitely variable hydraulic gear working on the same principle, but of somewhat different design, is supplied in this country by Weatherly Oilgear, Ltd., of Arch Street, London, S.E.1. The piston and cylinder assembly is shown in Fig. 108, and the appearance of a complete unit in Fig. 109. Units are made in a range of sizes from 2 to 150 H.P., operating with three pressures at choice 1100 lb., 1700 lb, or 2500 lb. per square inch. The characteristics of a typical oil gear unit are shown by the curves reproduced in Fig. 110.

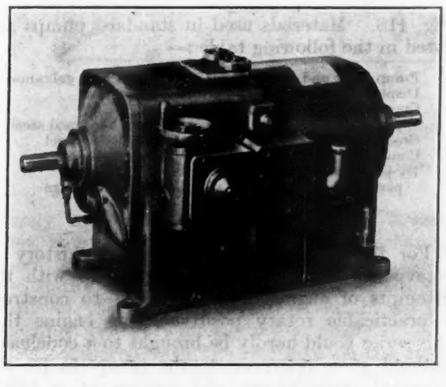

FIG. 109—HYDRAULIC VARIABLE GEAR—WEATHERLY

Another type of variable-speed hydraulic gear is that, of Universal Joint form, made by Pittler Werkzeugmaschinenfabrik. It is intended for use where specially high rotary speeds are required in distinction to the other Pittler machine just described which is particularly suitable for high pressures. Pump and motor are both mounted in a single casing which also contains the oil reservoir. The driven shaft A of the pump—Fig. 111—is linked through a ball-ended connecting-rod to the cylinder assembly B, which is carried on a journal bearing in a stationary tilting body. The cylinder assembly consists of a block of six cylinders all bored parallel to the axis of the body, and the pistons are linked through ball-ended rods to a disc on the end of the driven shaft. Owing to the angular displacement of the cylinder assembly the pistons reciprocate as the shaft turns. By the use of a hand wheel fitted to the pump the angular displacement of the cylinder body can be altered, thus providing for any delivery between zero and a maximum, and the angularity of the motor cylinder assembly being fixed, there results a variation in the speed of the output shaft.

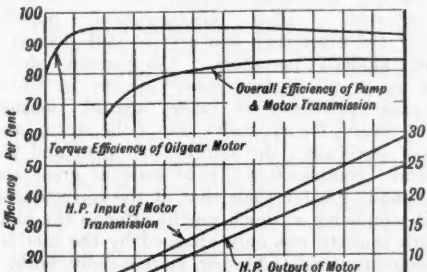

FIG. 110—CHARACTERISTICS OF VARIABLE GEAR

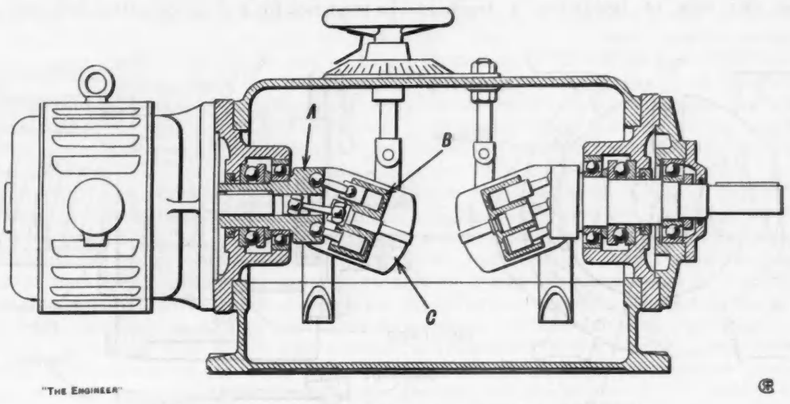

FIG. 111—HYDRAULIC VARIABLE GEAR—PITTLER

Miscellaneous Machines

Before concluding this series we desire to pick up a few "loose ends" and refer to certain machines of a variety of types which may prove to be of interest.

Differential.—During the nineteenth century the Differential form of design proved quite popular with inventors. But in the last forty years few machines seem to have proved at all practical, and about only one of these which we have come across is sufficiently known to make a reference worth while. At the Olympia Exhibition of 1910[1] there was exhibited by Lamplough and Son, Ltd., of Albany Works, Willesden Junction, the machine illustrated in Fig. 112. The driving shaft C carried at each end of the casing driving plates G G_1, each of which had four circular recesses machined in its face. A ring E worked in each recess and carried a pin E_1 to engage with one of the four pistons which were held in position against the casing by a floating ring A, surrounding the shaft. Owing to the fact that the shaft and the driving plates were arranged axially excentric with the casing, the pistons were caused, when the shaft was rotated, to approach and recede from one another with the distinctive differential action. It is interesting to relate that a blower built to this plan was shown at the Exhibition supercharging a small vertical two-cylinder gas or petrol engine. The advantages of supercharging were at that time fully realised theoretically, but apparently nothing had yet been done towards putting a practical machine on the market.

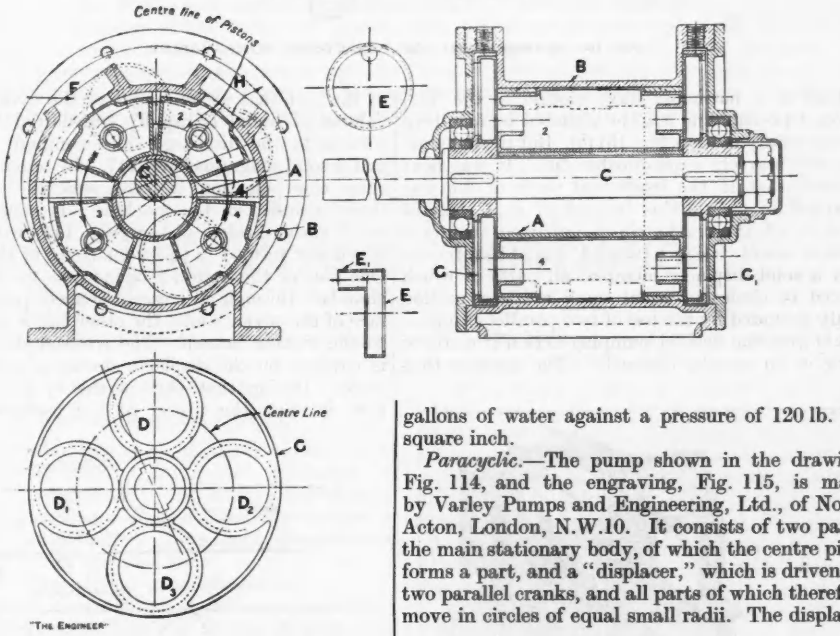

FIG. 112—DIFFERENTIAL BLOWER—LAMPLOUGH

Gear.—In the year 1914 or thereabouts there was invented in America the queer-looking gear pump[2] illustrated in Fig. 113. It had a central elliptical gear, a more or less square-shaped fixed outer internal toothed gear, and six intermediate planetary pinions. On rotating the central gear, the planets moved round with unequal speeds, thus producing a pumping action. This curious machine was the invention of a Mr. Dock, of Rhode Island, and, strange though it may seem, it was thought worth while to make at least one machine. It was 9½in. diameter by 2½in. long, and was submitted to a 100 hours' endurance test at 800 r.p.m., pumping in that time an aggregate of 1·1 million gallons of water against a pressure of 120 lb. per square inch.

Paracyclic.—The pump shown in the drawing, Fig. 114, and the engraving, Fig. 115, is made by Varley Pumps and Engineering, Ltd., of North Acton, London, N.W.10. It consists of two parts, the main stationary body, of which the centre piece forms a part, and a "displacer," which is driven by two parallel cranks, and all parts of which therefore move in circles of equal small radii. The displacer has therefore a "Paracyclic" motion. In the centre piece and in the displacer there are disposed a number of spring-loaded contact strips through which contact is made between the two parts. The working cycle is adequately shown by the series of drawings in Fig. 117.

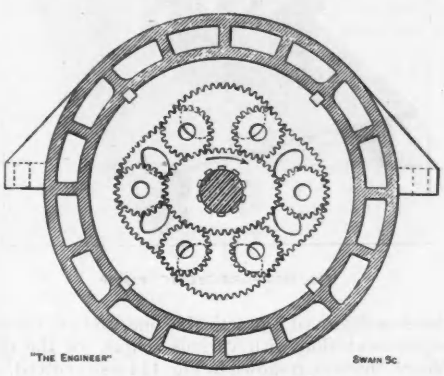

FIG. 113—DOCK'S PUMP 1914

A reference back to Galloway's machine of 1846 will show that the Varley pump has an affinity of action with it, for in that machine also all parts moved in circles of small and equal radii. Curiously enough, however, the derivation of the Varley pump can be traced from quite a different kind of machine. It was developed soon after the war by Commander C. H. Varley, whose original conception was that of a flexible displacer, having harmonic wave motion in a straight conduit of rectangular section, Fig. 116 (*a*). From this somewhat impractical conception there was easily developed the idea of imparting a trochoidal instead of a harmonic wave motion to the displacer, thus enabling it to be actuated by members having rotary motion, Fig. 161 (*b*). But the machine was still scarcely a practicable one. It was next realised that if the trochoidal wave device was arranged in an annulus instead of in a straight conduit, all the cranks which imparted the wave motion could become parallel (Fig. 116 (*c*)), and that a solid displacer member, all parts of which moved in circles of equal small radii—a motion easily provided by the use of two parallel cranks—would give the desired pumping action if made to work in an annular channel.* The machine thus developed proved a practicable one, and after some experimentation with various shapes for the displacer, the design shown in Fig. 114 was evolved.

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[1] The Engineer, Vol. XC, page 299.

[2] *American Machinist*, May 7th, 1914.

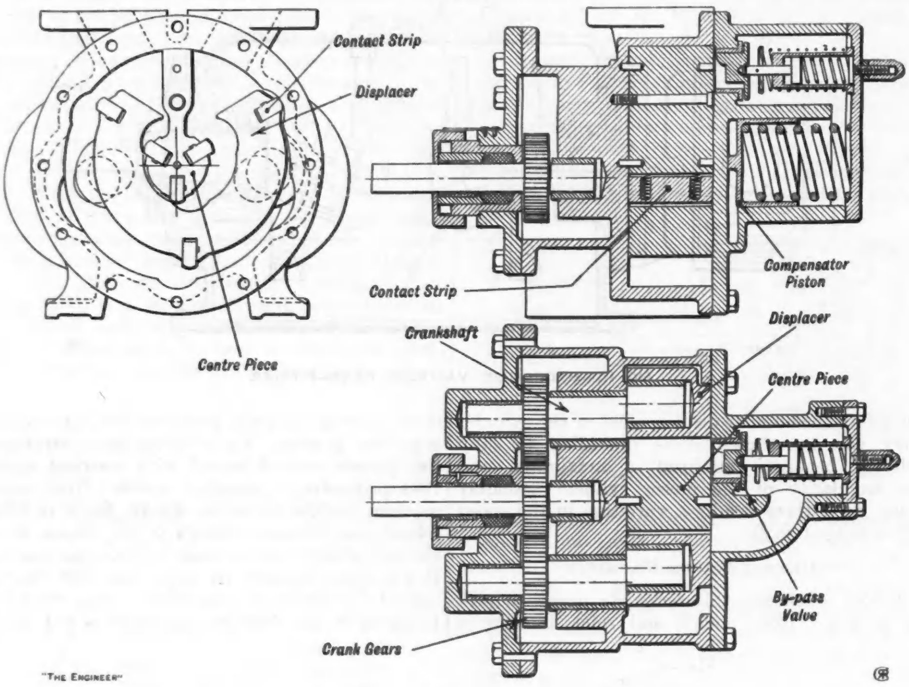

FIG. 114—ARRANGEMENT OF PARACYCLIC PUMP—VARLEY

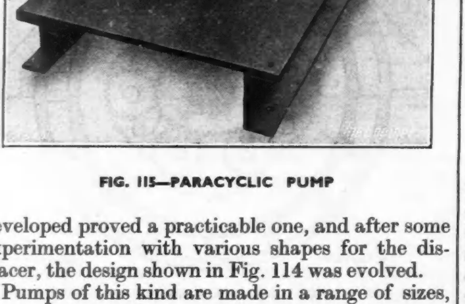

FIG. 115—PARACYCLIC PUMP

Pumps of this kind are made in a range of sizes, giving deliveries between 120 and 5000 gallons per hour, and have been found suitable for handling petrol, fuel oil, paraffin, lubricating oil, methylated spirits, &c. They have been supplied in large numbers for petrol and oil dispensing, and for the supply of lubricant to machine tools. They have the important advantage, owing to the large clearances and the ease with which the spring-loaded strips can ride over any obstruction that they can pump fluids with solid matter in suspension without suffering any damage. Moreover, in distinction to many other forms of rotaries, the wear, if any, that takes place on the end covers is uniform, and therefore easily corrected. The makers state that a volumetric efficiency of 96 per cent. can be and is attained, and that the rate of discharge varies only about $2\frac{1}{2}$ per cent. on each side of the mean rate. Nevertheless, it has been found that there is a tendency for a cyclic pulsation to be set up, owing to the fact that at one point of the cycle a large volume of liquid is rapidly transferred from the suction to the discharge side—compare the first and second diagrams, Fig. 117. In order to overcome this pulsation, a "compensator" is sometimes included in the machine. It consists of a small spring-loaded piston (Fig. 114) working in a cylinder formed in the front cover of the pump. One end of the cylinder opens into the pumping chamber through a crescent-shaped port in the face of the cover, whilst the other end is connected to the suction branch. The crescent-shaped port is covered by the displacer during a part of the cycle. During that part of the cycle when the port is open the piston of the compensator is forced back as liquid under the discharge pressure enters the cylinder. The port being then closed by the movement of the displacer, there is left stored in the compensator a volume of liquid under discharge pressure. Just as the displacer is about to reach the critical point in the cycle, the crescent-shaped port begins to be uncovered, with the result that a small volume of liquid is forced by the spring pressure into the pumping chamber, thus gradually raising the pressure therein towards that in the discharge pipe and preventing that sudden change of pressure which is the cause of the pulsation. Pumps are also fitted with spring-loaded relief valves, one of which is shown in the drawing. The firm now has under development a form of the pump which will provide an absolutely uniform discharge, and another in which the bearings of the driving mechanism will not be in contact with the liquid pumped.

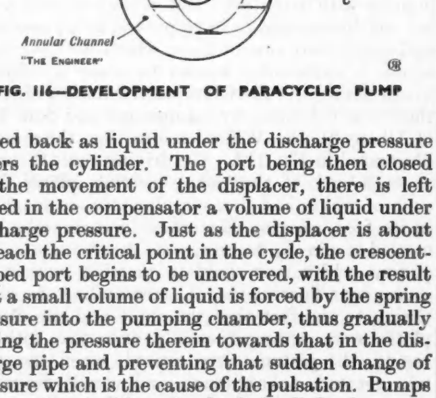

FIG. 116—DEVELOPMENT OF PARACYCLIC PUMP

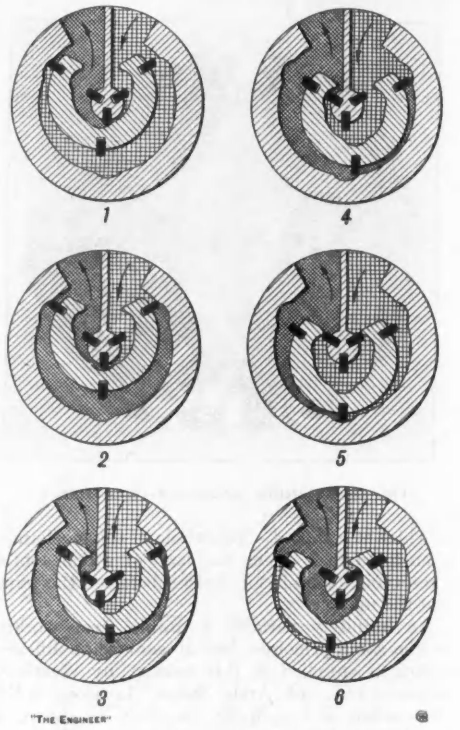

FIG. 117—CYCLE OF PARACYCLIC PUMP

The drawing relates to a pump with suction and discharge branches, 2in. diameter, running at 650 r.p.m., and giving a delivery of 50 gallons per minute. Characteristics of four pumps of different capacities are revealed by the curves reproduced in Fig. 118. Materials used in standard pumps are listed in the following table :—

Pump body and covers ...	Grey cast iron galvanised
Displacer and centre piece ...	Grey cast iron
Crankshafts and driving pinion	Nitrogen hardened steel
Crank gears	Oil-toughened steel
Contact strips	Manganese bronze
By-pass valve : Compensator piston	Gun-metal castings

CONCLUSION

For the past 150 years or so the history of rotary devices has been so bound up with the attempts of engineers—and others—to construct a practicable rotary positive-acting engine that this series could hardly be brought to a conclusion without some reference to the prospects for the eventual development and success of a rotary steam or internal combustion engine. As this history has revealed, no rotary, with the exception of certain Concealed Reciprocator devices of small size which did manage to flourish for a short period towards the end of the nineteenth century, has ever challenged the supremacy of the reciprocating engine—far less that of the steam turbine or the internal combustion engine. We do not believe one ever will.

When the rotary was first developed it was considered to be a machine much simpler in its mechanical arrangement than the conventional reciprocator. That misconception, popular during the nineteenth century, is still deceiving some modern inventors. Comparison shows that in a satisfactory rotary design in which adequate provision is made against leakage of the steam, for expansive use of the steam, and proper governing, the number of parts and the general "complication" is at least as great and far usually greater than that of the reciprocator. That simplicity so much sought after in the nineteenth century was only attained by the sacrifice of economy or reliability, or, more usually, both.

As a consequence of the fact that the rotary has in general proved a failure during the past century, a belief has grown up that there is something inherently wrong with the mechanism which will always prevent it from achieving those very necessary qualities, reliability and durability. But we are not convinced that the rotary can justly be condemned in such an arbitrary manner. Much more complicated mechanisms have been made reliable as a result of the unremitting efforts of generations of engineers striving towards a single end. We see no reason to believe that similar efforts directed towards perfecting the rotary engine should not yield equally encouraging results. The adverse opinion of the mechanism has derived support in each generation because the attention of engineers has seldom been concentrated upon a single basic idea, but has been given to a large number of different designs to the general detriment.

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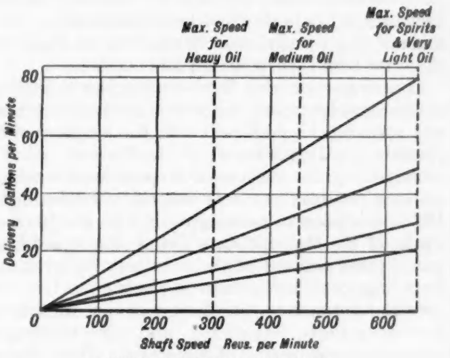
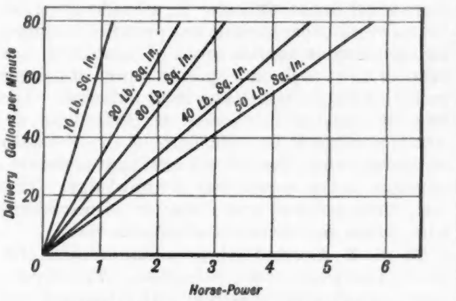
* Incidentally the diagram, Fig. 116 (c) reveals a connection between this device and an ordinary excentric machine.

It is also claimed that the rotary idea is not adaptable to any but very small machines. There are clearly features of rotary design which make the construction of even medium size machines a matter of considerable difficulty. But we refuse to believe that it is beyond the wit of engineers to find means of overcoming such purely mechanical difficulties. In fact, it seems that, regarded purely as a form of mechanism, there is nothing about the rotary that makes it necessarily inferior to the reciprocator, although many of the rotary devices tried out in the past certainly were very inferior mechanically.



PUMP CAPACITIES AT VARIOUS SPEEDS



HORSE-POWER REQUIRED AT VARIOUS PRESSURES

"The Engineer"

FIG. 118—CHARACTERISTICS OF VARLEY PUMPS

As compared with the reciprocator the rotary engine has, at least in theory, some distinctly advantageous qualities. It provides a constant or nearly constant running torque without dead points, combined with a high starting torque, and it has a relatively high power-weight ratio, a resultant of its capability for running at a high speed. It might therefore be reasonably expected that were its reliability and economy to be raised to a level comparable with those of the reciprocator, it should be able to challenge the supremacy of the conventional engine. Indeed, it may be significant in this connection that for a short period towards the end of the nineteenth century, as a result of the attention of competent engineers, certain rotary engines of Disc, Universal Joint, and Concealed Reciprocator types did actually manage to do so, though only in the very smallest power range. The subsequent failure of machines of the kind concerned to consolidate their advantage, can be traced partly to the fact that they were considerably more complicated and expensive to manufacture than conventional engines. Thus they were unable to meet the challenge of the turbine and the electric motor, which were later developed and proved capable of undertaking the same tasks and performing them with equal satisfaction at less cost. The rotary can, indeed, claim only one quality that the turbine does not possess. It shares with the reciprocating engine the ability to develop a high starting torque. But in every other respect the turbine has the advantage except, perhaps, in economy of running in the smallest sizes. It has a lower power-weight ratio, a constant torque, it is a simpler mechanism, and it is less costly. Thus it may be said that to-day and in the future the rotary will retain a theoretical advantage as compared with the reciprocator, but that before any such advantage could be realised in practice much development work would need to be done to make the rotary mechanism reliable, and means would have to be found so to reduce its price that it would be able to compete with the turbine and the electric motor, devices that have very similar qualities and have proved themselves satisfactory for performing just those tasks to which the rotary is best adapted. The advantages of the rotary engine being so slight, if any, as compared with its competitors, we cannot believe that engineers will consider it worth while to bestow that attention upon it necessary to make it a reliable and practicable device and so have no hesitation in stating that the development of a rotary steam engine is impossible, if not in contemplation, in fact. But that statement must not be taken to apply to concealed reciprocator machines whose design is closely similar to that of conventional engines.*

But though the chances of the successful development of a rotary steam engine seem thus very remote, many inventors during the last forty years have considered matters less unfavourable in regard to a rotary internal combustion engine. At first sight, indeed, the rotary does seem to have better chances in this field. The internal combustion turbine has so far made but little headway, so that competition lies only against the engine, and the latter is a far less simple device than the reciprocating steam engine. The objections, moreover, that can be urged against the rotary are concerned with mechanical rather than any other deficiencies. There are obvious problems of heat transmission and cooling, of wear resulting from the presence of carbon, of preventing the erosion and burning away of the edges of inlet and outlet ports, of scavenging, and many other things. Yet it is conceivable that if the attention of engineers were concentrated for a generation or two upon a favourable design, solutions to such problems might be found. But it is, to say the least, very doubtful whether the resultant engine would have any special qualities to recommend it. It is unlikely that it would be a more simple or less costly machine and very improbable that it could attain a power-weight ratio higher than that of existing high-speed, high-performance oil and petrol engines. As in the case of the steam rotary, we are therefore quite unable to believe that any competent engineers will consider it worth while to concentrate the necessary attention upon a suitable rotary design for a sufficient length of time.

One other remark may be made before the concluding words of this series are written. It is almost a truism nowadays to say that mere invention is relatively unimportant. No better illustration of the fact could be provided than the history of the positive-acting rotary. Thousands of inventors have filed specifications for rotary engines or pumps at the Patent Office. Yet the relatively few machines that exist to-day owe their success far less to the insight of the original inventor than to the long months or years of arduous experimental work that followed upon the filing of the original patent before the machine could even be introduced to the market with any reasonable prospect of success. During that experimental work some original conceptions became so altered that it is difficult to-day to recognise where the connection lies between the original machine and the final product. The development of the Varley "Paracyclic" pump and the Drum roller machine are cases in point. Sometimes the name of the man to whom the original conception is due has been long forgotten—although his patent is still usually to be found by the curious amongst the files at the Patent Office—and later generations have made improvements to a device which, in the language of patent specifications, is an already "known" one. Modern Crescent blowers leap to the mind as examples, being the practical realisation of a type of pump invented by Ramelli a couple of centuries or so ago. If we may be permitted to draw a moral, we should say that nowadays it ought to prove more profitable to pick upon some "known," but heretofore unsuccessful, rotary device and examine by what means it can be converted into a practical machine, than to attempt the difficult, but relatively much simpler, task of devising some entirely new rotary mechanism, the practical defects of which will still need to be discovered.

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* The Gnome aero-engine so successful during the War could be regarded as a rotary. Its design was, however, almost identical with other radial cylinder machines, the only difference lying in the fact that the crankshaft was stationary and the cylinders turned around it.

The British Association

No. III

(*Continued from page* 274, *Sept.* 15*th*)

Section L (Education)

Education for Industry

On Thursday morning, August 31st, Dr. A. P. M. Fleming, C.B.E., the President of Section L (Education), presented a Presidential Address, in which he dealt with the subject of education for industry. This address was reprinted on p. 274 of our previous issue.

It was followed by a general discussion.

Mr. W. O. Lester Smith (Director of Education, Manchester) in a written communication, discussed education as a preparation for industry from a local authority standpoint. Co-operation between industry, local authorities, and teachers was of vital importance to industrial prosperity. Every effort should be made to break down any barriers or prejudices which existed, one of which was the difficulty which rationalised industry found in maintaining active contact with local affairs.

He regarded the Hadow Report as the most constructive educational document of the present generation, and he was inclined to think that the Spens Report would run it close in that respect. From the standpoint of industry, the recommendation of the provision of technical high schools as a new type of secondary school was very important, and it embraced as a consequence a suggestion that junior technical schools which "have a technical value in relation not to a particular occupation, but to a group of occupations," should be converted into technical high schools.

Speaking of the disadvantages of evening class work which was of an intensive nature, Mr. Lester Smith suggested that it was time, both in the interests of youth and industry, that the State—as the Fisher Act intended—should provide continued daytime education and guidance for all young people, the value of which had been so clearly demonstrated at Rugby and by enlightened firms in several industrial centres.

That education and industry could collaborate with great mutual benefit was shown by the first fruits of the regional movement in Technical Education stimulated by a Conference Report on "Co-operation in Technical Education" issued by the Board of Education in 1937. By way of illustration he mentioned the work of one such Advisory Committee in his own region during the last two years, whose task was to survey the need for advanced teaching in the mechanical and electrical industries. This Advisory Committee was fortunate in having Dr. Fleming as its Chairman, and working with representatives of the Institutions of Mechanical and Electrical Engineers it had surveyed available facilities and made suggestions for new advanced courses of approximately post-graduate standard, the attendance at which had indicated a demand which exceeded all anticipations. It had been said by a Principal of great experience—Mr. Paley Yorke—that "one of the difficulties of close co-operation with an industry as a whole lies in the fact that not all industries are organised for co-operation," and it had also been observed by Principal Richardson of Derby that "On the whole it is the more modern industries, those dependent more directly on scientific principles and those which have arisen out of modern research, that are the most anxious to educate their people and place some value on education."

Dr. K. Fisher (Headmaster of Oundle School) commenting on the marked improvement during recent years in the connection between industry and the public schools, said the anxiety of employers to find public school boys to enter their service was increasing rapidly, which was most gratifying. From his own school something like

35 to 40 per cent. of the boys went into industry, either directly or indirectly.

He stressed the importance of foreign languages as well as English and said that there must be an intimate union of practice and theory and an economic foundation behind the curriculum.

Mr. D. Shillan (University of London Institute of Education) said that when he had visited the U.S.S.R., in 1932 he found that every school corresponding to our own secondary schools in status was attached to the nearest factory or firm, and that the boys went into the factory and were instructed on the plant as they found it, instead of being instructed on full size plants at school. The fact that the processes with which the children came into contact were real and were producing something, seemed to him to have a very great cultural value. At that time there was a seven years period—from 8 to 15 years of age. Those who did not go straight to work on leaving school spent a period in college and then another spell in a factory before going to a university. During a recent visit to the U.S.S.R., he had found that a much more academic type of curriculum had been adopted. He was told that under the old system too much time was lost in the works and they could not keep up the necessary academic standard to enable their young people to take their place in competition with the world. The school training had been extended to a period of 10 years, *i.e.* from 8 to 18 years of age in the cities, and in no circumstances did the pupils enter industry before they were 18. Those who were going on to universities were given further training before the university stage.

Dr. G. T. P. Tarrant urged that if the boys in the schools did not know about industry, the only boys who would enter industry would be the mediocre, and therefore he suggested that the schools should be given better opportunities to learn about the conditions in industry. As a teacher, he had never had any opportunity to estimate the sort of financial return that the average boy of good higher certificate standard might reasonably expect. He suggested that industries might send to the schools people who could describe the conditions of service and give an idea of the financial rewards that industry could offer.

The debate was continued on Friday morning, September 1st.

Mr. John B. Longmuir (Mavor and Coulson, Ltd., Glasgow), said that with a few notable exceptions, there was no organised and systematic workshop training in Scotland, and apprentices either " picked up " their trade themselves or had to rely on a sympathetic foreman or on the journeymen. The position of technical education was equally unsatisfactory. With the exception of the printing industry and a few isolated local attempts, there was no co-operation between education and industry to discharge their joint obligations. For that, industry was as much to blame as education, and employers had not always made certain that their young employees took full advantage of facilities provided. There would be no real progress in technical education until co-operation was effective and employers took more interest in both day school and technical education.

The foundation of all education, he continued, was the day school system. He commented on the general impression that the Scottish day school education was second to none, and said it could not be agreed that the foundation was well laid for the great majority of young people. Scottish education had exploited the many for the sake of the few who would bring honour to the school or college. An opportunity presented itself now to liquidate the debt to the great majority of pupils, who had been so long neglected and fobbed off with an inferior education. With the raising of the school leaving age all pupils would have an opportunity to receive a three years advanced course.

Summarising the educational requirements for those in industry, Mr. Longmuir advocated a bolder policy of grading, which would give the pupil free choice of a course suitable for his occupational desires. With regard to day school educational requirements he emphasised that for those in industry those requirements were the same as the requirements for the full enjoyment of leisure hours.

It was suggested that our education should be less bookish, and that the attempt to convert all our secondary schools into miniature universities should be stopped. Less ground should be covered in every subject and there should be more practice ; less talk from the teachers and more performance in school from the pupils. It was found that boys who had done little or no handwork at school and whose engineering training did not start until 17–18 years made very slow manual progress and never succeeded in reaching the dexterity of the boys with a handwork training who started work at 15–16 years.

The ideal method was to set up in every large city or town a Junior Technical School, such as those in Coatbridge, London, and Birmingham. Such a school would provide, in addition to the three years course, a five years course leading to a central institution. In time the University Entrance Board would have to accept such a certificate for entrance to a university. One traditional higher grade day school in each county, city or region would provide for the less than 10 per cent. who desired, or were capable of taking, a leaving certificate to enter an arts degree course at a university. The Junior Technical School would be the centre of evening continuation class education, and its courses would lead direct to continuation classes.

Principal J. Cameron Smail (Heriot Watt College, Edinburgh) said that technical education in Britain had been built up largely on part-time education, mainly in evening classes. The results had undoubtedly justified the scheme, but the strain on individuals was considerable. Day classes had been in operation in dockyard schools and various works schools and in particular industries such as printing, but no joint national scheme was operating. The outstanding results of the dockyard scheme showed the possibilities for educated students. The personnel for control, organisation, administration and design had been largely recruited through part-time education. The psychological value of the " sandwich " system was insufficiently appreciated, and further investigation was desirable.

The basis of education now being extended by the raising of the school leaving age should provide pupils with a slightly wider background and more advanced intelligence. The difficulties ahead lay in designing adequate and effective courses for young people in beneficial employment and for those who remained at school a year or so longer.

There might be some danger of a too narrow view being taken of the whole field of technical training, involving the application of scientific principles to the practice of industry. There was also the possibility that teachers in technical schools might not retain full contact with workshop and factory processes and methods. For that purpose, contact with works managers was very necessary, so that instruction methods might be adjusted from time to time.

Dr. F. T. Chapman (Board of Education), who was for 20 years an engineer, said that the most urgent educational problem before industry in this country at present was the training of craftsmen. The training of technologists was in a much more satisfactory position, though capable of improvement in detail.

Dealing mainly with the training of craftsmen, and from the point of view of the engineering industry (though most of his remarks were of wider application), he said that for craftsmen, as well as for technologists and for managers and administrators, the training presented three aspects —the learning of techniques, the acquisition of skill, and the study of technology.

As an ideal training for a skilled craftsman he suggested recruitment at the age of thirteen to a junior technical school or trade school ; followed by an apprenticeship terminating at twenty to twenty-one, during which half or more of the first two or three years was spent in an apprentice school either within, or closely associated with, the works.

Apprentices with special ability would come to the front in the apprentice school, and for them special opportunities for further education should be provided on a part-time or sandwich basis for the remainder of their apprenticeship ; in special cases that would be followed by two years full-time education which would lead to a degree. Thus, such a scheme would produce, besides a supply of good craftsmen, a stream of men well qualified to occupy posts on the managerial and technical staff.

Professor Willis Jackson discussing " Post-advanced Education " dealt with a very recent development in technical education which he regards as of the greatest importance.

In some cases post-advanced instruction was provided within industrial organisations as an integral part of their training schemes. That was the case at the Metropolitan-Vickers Electric Company, the Marconi Company, and the Engineering Section of the Post Office, but concerned their own employees only. He drew attention, however, to the provision made in certain local technical institutions, acting in close co-operation with surrounding industrial concerns, for the benefit of members of those concerns as a whole. In view of the direct association with it of both Dr. Fleming and himself, he mentioned first the scheme of post-advanced lecture courses in electrical and mechanical engineering organised by the Regional Advisory Council which is responsible for co-ordinating technical and other forms of further education in the Region comprising the Counties of Cheshire, Derbyshire, Lancashire, and the West Riding of Yorkshire, acting in collaboration with the Institutions of Electrical and Mechanical Engineers. The same Regional authority acting in collaboration with the Society of Chemical Industry and the Institute of Chemistry had been operating a similar scheme of post-advanced instruction in chemistry since 1931, in Liverpool and Manchester.

Contemporary with those developments in Manchester and Liverpool, an essentially similar scheme was operated in Sheffield under the auspices of the Engineering Departments of the University. Encouraged by the success of a specialised course of evening lectures on railway electrification during the 1937–38 session in collaboration with the Sheffield works of the Metropolitan-Vickers Electrical Company, three courses of about twenty lectures each were organised last session on electric traction with special reference to the design of d.c. motors for city transport ; lighting ; and the mechanical properties and testing of materials. Those lecture courses attracted many men occupying quite senior positions in the surrounding industry, in addition to their more junior colleagues, but as many of them experienced difficulty in attending regularly on one evening per week, it was proposed to organise for next session shorter series of from three to six lectures only, each on a specific aspect of technical problems important to the local industry. Those recently organised schemes of post-advance instruction offered, he said, none of the attractions of degrees and afforded no artificial examination stimulus to the acquisition of knowledge. Therefore, their success was a matter of considerable educational significance and importance.

Mr. S. E. Goodall (Metropolitan-Vickers Electrical Company, Ltd.) described the form of apprenticeship developed by his Company some twelve years ago, covering a period of five years practical and theoretical experience, and said the accumulated evidence of the past seven years since the first apprentices had completed their five-year periods of training after leaving school had fully justified the experiment. Increasingly the opinion was held that the advantages of that course were greater in the aggregate than those which could be claimed for previously existing arrangements.

The meeting of all sections of the Association was abandoned on the afternoon of Friday, Sept. 1st.

Prizes for Bridge Design

For some years an annual award for the best designs of bridges built during each year has been made by the American Institute of Steel Construction, the bridges thus selected being marked by bronze plates bearing the inscription : " The Most Beautiful Steel Bridge in its Class ; Completed in 19—." The selection is made by a board of five members, including engineers, architects, a professor of civil engineering, and an artist. For 1938 the awards were as follows :—Class A, bridges costing more than £200,000 : The bridge over the Connecticut River at Middletown ; steel truss arches of 600ft. span, with deck carried by hangers from the arches ; total length, 3400ft.; cost, £600,000. Class B, bridges costing from £50,000 to £200,000 : the bridge over the Kentucky River at Frankfort ; a continuous girder structure having three continuous spans ; centre span, 200ft.; side spans, 137ft.; the plate girders have curved bottom flanges ; there are also three girder spans of 67ft.; cost, £66,000. Class C, bridges costing less than £50,000 : continuous deck truss bridge over the Flathead River in Montana ; continuous trusses for a central span of 168ft., and two side spans of 84ft.; the bottom chords are curved or arched ; total cost, £15,000. Class D, movable bridges : The Franklin Avenue Bridge over the Saginaw River at Bay City ; a double-leaf bascule span of 185ft. with plate girder leaves having curved bottom chords ; two girder flanking spans of 98ft. and 108ft.; a masonry tower of architectural design houses the operating room ; all deck spans ; cost, £76,000. Honourable mention was awarded to a cantilever bridge of 871ft. main span in Class A ; a long continuous deck girder bridge in Class B, and a 348ft. steel rib arch span and a 115ft. welded rib arch bridge in Class C. The purpose of the awards is to encourage attention to pleasing appearance as well as the technical features of design.

Instruments in Science and Industry[*]

By ROBERT S. WHIPPLE

No. I

I FEEL that it is a great honour to be chosen as President of Section A, particularly because on looking through the names of my distinguished predecessors I find that I am the first professional maker of scientific instruments to occupy this Chair. My immediate predecessor, Dr. C. G. Darwin, who now occupies the important position of Director of the National Physical Laboratory, gave us at Cambridge a brilliant dissertation on the use of mathematics in solving physical problems, and the need of the mathematical outlook when facing a series of facts requiring solution. He would, I am sure, be one of the first to insist that the mathematician requires physical facts to enable him to develop a physical theory, and that the probable soundness of the theory will depend largely upon the accuracy of the data discussed. In the majority of cases this accuracy depends on the qualities of the apparatus employed in the observations, assuming that the observer is fully qualified and capable of obtaining the best results from it. I believe that all such observers now demand far more from their apparatus than was formerly possible, but few realise the amount of thought and labour involved in raising the accuracy obtainable from one to one-tenth of one per cent.

The help that instruments have given to the advancement of science is a fascinating theme, and at the same time a wide one. Amongst the earliest and most striking examples we find that Kepler was able to state his Laws of Planetary Motion as a result of the observations made with Tycho Brahe's carefully constructed instruments. Tycho (1546–1601) first introduced (though he did not discover) the method of transversal division of the arc, which is now familiar to us as the basis of the diagonal scale. It was he who first pointed out the importance of symmetry in an instrument. The ingenious naked-eye sights developed by him were a remarkable improvement on the simple sights previously used. According to Dreyer [1] his determinations of the right ascensions and declinations of his nine standard stars show a probable error of less than thirty seconds of arc—an almost incredible achievement.

I propose to consider a few well-known instruments and to use them as examples to indicate how the development of a particular subject has grown largely with the perfection of the instruments used to investigate it. It is in every way a reciprocal process. By means of an instrument certain evidence is obtained; this evidence does not go far enough and the instrument must be improved to enable further facts to be found. If, for example, the biologist requires to examine small bodies beyond the range of his microscope, he appeals to the physicist to help him, and the appeal is not in vain. Most probably, as a result of the work on his colleague's problem, the physicist develops a technique which will be of service either to him or to a fellow-physicist.

As examples of instruments primarily used to extend the range of our senses I will take the microscope, telescope and spectroscope. Their development has a long history, and each can be adapted to yield accurate measurements by the addition of suitable devices. Thus we are led to the application of the mechanical arts to the division of angles and lengths in dividing engines and the measurement of time by various appliances which may be considered as supplementary to those first mentioned. To exemplify classes of instruments whose use rapidly extended from the laboratory to the industrial field I will review those employed in temperature measurement including the galvanometer, and, as an example of the rapid application of new physical knowledge by the instrument maker, the thermionic valve as applied to measurement.

THE MICROSCOPE

The first example I shall take is the microscope, an instrument which is used in every observational science and, in some form or another, in nearly every industry. The early story of the microscope has been often told, and yet it may be of interest to recall the most important stages in its development. The first instruments consisted of single lenses, actually small globules of glass, which, when the surfaces were suitably ground, yielded in the hands of skilled observers surprisingly good results. The outstanding example is the Dutch naturalist Leeuwenhoek, who during the period 1674–1723, using a microscope of this type, discovered the protozoa and bacteria, and made many other biological observations of supreme importance.

Hooke, who was Leeuwenhoek's correspondent, was working at microscopical problems at the same time, and in the *Micrographia* (1665) described his own microscope—the first compound microscope. The optical system of this instrument consisted of a converging lens, called the object-glass, the field lens, and a third lens, the eye lens. Although it has been stated frequently that Hooke first introduced the field lens to enlarge the field of view, there is little doubt that this invention was due to Monconys, who published a short description of a compound microscope made to his design in 1660. This hardly detracts from the credit due to Hooke, whose publication became so generally known, and whose optical system was universally adopted and remained practically unchanged for over a hundred years.

Hevelius, in 1673, described in his *Machina Coelestis* a screw-focusing adjustment that he had fitted to an instrument of the Hooke type which was the forerunner of the modern mechanism adopted (or invented independently) by John Marshall (1663–1725), one of the great opticians at the close of the seventeenth century. Marshall should be remembered by the fact that he was the first to introduce the method of grinding a number of lenses simultaneously, by cementing a number of pieces of glass on to the surface of a large convex spherical block, and working them with a concave spherical tool. This is still the method employed for polishing lenses in quantity. In the modern spectacle lens factory as many as 150 are sometimes polished in one block.

Although many variations in the design and mechanical construction of the microscope were made during the eighteenth century and the early years of the nineteenth, yet there is no invention of fundamental importance to record until the construction of the achromatic objective. This was first successfully completed by the French optician Chevalier about 1825 and in England by Tulley working about the same time to the designs of Joseph J. Lister, nearly sixty years after the construction of a successful achromatic telescope objective.

Abbe carried the corrections of the aberrations to a far higher degree of perfection notably by using glasses of new types which at his suggestion had been worked out by Schott, to produce, about 1886, the so-called apochromatic objective in which the colour correction was greatly improved.

It is difficult to see how the resolving power of the microscope is to be further increased using light from the visible region of the spectrum. The biologist, and particularly the medical man, is anxious to study organisms the structure of which is too fine to be resolved by any object glass when using ordinary white light, the alternative to which is the employment of rays of shorter wave length, viz., the ultra-violet. Glass lenses are opaque to these short wave lengths, and therefore lenses made of fused quartz must be used. J. E. Barnard, who has developed a very successful technique in connection with ultra-violet microscopy, has shown that it is possible to study and photograph living bacteria, which are normally transparent to light from the visible region of the spectrum, without staining and therefore killing them. The use of such short wave lengths has necessitated the construction of extremely rigid mountings in the microscope body and complete absence of play in the moving parts of the instrument. As showing the perfection of the technique obtained with ultra-violet microscopy, it may be mentioned that it is possible to take a series of photographs of an object in successive parallel planes separated by distances of the order of 0·0002 mm.[2]

The use of short wave radiations has proved so successful in the case of the ultra-violet microscope that a technique has been developed which offers great possibilities for the use of still shorter radiations. As is well known, a beam of cathode rays can be brought to a focus by passing the beam through a magnetic or electrostatic field, in a manner very similar to that in which light is brought to a focus by a convex lens. In the same way, an electron image of a surface may be formed owing to the fact that the electrons will be scattered by an amount depending on the density (or mass concentration) of the surface on which they impinge. By forming the image on a fluorescent screen it can be rendered visible, or if projected on to a sensitised plate photographically recorded.

In an instrument designed by Von Borries and Ruska,[3] an electron stream is passed through two specially designed electro-magnets (or magnetic lenses), mounted one above the other, which act as equivalents to the objective and eye-piece of an optical microscope. If an object is placed between the poles of the lower magnet some of the electrons will be scattered by the material of the object and others will be diverted by the magnetic flux so as to form an image of the object in a plane below the magnet. That an image can be formed in this way depends upon the fact that the scattering is proportional to the mass concentration at different parts of the object. The scattering will be greater from the thicker parts than from the thinner ones, and thus the dark parts of the image will correspond to the thick parts of the object, and *vice versa.* Magnifications of about twenty times those obtained with the optical microscope can be obtained. Excellent photographs have been taken of bacteria and bacilli at magnifications of 10,000 and 20,000 diameters.

In 1854, Jabez Hogg, in his introduction to *The Microscope*, states: "It is not many years since this invaluable instrument was regarded in the light of a costly toy; it is now the inseparable companion of the man of science." In the same preface he mentions that in 1841 the Council of the Royal College of Surgeons had determined "to form a collection of preparations of the elementary tissues of both animals and vegetables, healthy and morbid, adapted to illustrate the uses and results of microscopical investigations."

It is in medical science and the sciences allied to medicine that the greatest use for the microscope is still found. In the study of zoology, physiology and botany it is essential; but it is only when its employment in the pathological laboratories of the world is visualised that its importance is clearly understood. A microscopical examination frequently settles the question of the type of disease from which a patient is suffering, and in the whole story of hospital practice there is no spectacle more dramatic than that of the surgeon suspending an operation to await the result of the pathological examination of a tumour suspected of malignancy.

Sorby, in 1864, was the first to investigate the structure of metals and alloys by the microscope, and although it was some considerable time before his work was appreciated, there is now no metallurgical laboratory worthy of the name that does not possess a microscope by means of which the molecular structure of an alloy can be examined and photographically recorded. How important this side of the work has become is shown by the fact that the majority of scientific papers dealing with problems connected with alloys are illustrated by micrographic prints.

THE TELESCOPE

Although the discovery of the telescope antedated that of the microscope, in its service to mankind it ranks as second to it. The credit of the invention of the telescope must go to a Dutchman, Lippershey; yet it was Galileo who first produced an instrument worthy of the name. He ground and polished his own lenses, and in 1610, with a telescope magnifying thirty-three diameters, discovered the satellites of Jupiter. Amongst his many astronomical observations he discovered the phases of Venus, and estimated the height of the lunar mountains from the length of their shadows.

Newton pointed out that the focal length of the refracting telescope could not be reduced owing to the refrangibility of light of different colours, and that it was not possible to focus for all the colours simultaneously and thus obtain a sharp image. He measured and calculated the distance between the foci of the red and violet and showed that it was about 1/50th the diameter of the lens. It was to overcome this difficulty that the glasses were made small and of long focal length. It is almost unbelievable that James Bradley, in 1722, measured the diameter of Venus with a telescope having a focal length of 212ft.,[4] the supporting mast being about 45ft. long.

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[*] British Association. Presidential address to Section A. Mathematical and Physical Sciences.

[1] J. L. E. Dreyer, *Tycho Brahe*, p. 351 (1890).

[2] L. C. Martin and B. K. Johnson, "Ultra-violet Microscopy," *Journal of Scientific Instruments*, V, p. 337 (1928); and VII, p. 1 (1930).

[3] Bodo von Borries und Ernst Ruska, "Vorlaüfige Mitteilung über Fortschritte im Bau und in der Leistung des Ubermikroskopes," *Wissenschaftliche Veröffentlichungen aus den Siemens-Werken*, 17, p. 99 (1938).

In 1663, James Gregory suggested the construction of a reflecting telescope, and in 1668 Newton constructed the first practical instrument, having made his own alloy for the mirror and having devised methods for grinding and polishing it. A sentence in his *Opticks* (Bk. I, Pt. 1, Prop. VI, p. 75) shows how serious the position had become: "Seeing therefore the improvement of Telescopes of given length by Refractions is desperate; I contrived heretofore a Perspective by reflexion, using instead of an Object Glass a concave Metal."

The manufacture of satisfactory reflectors was very difficult, and it was not until an instrument maker, James Short of Edinburgh, about 1730, produced instruments with parabolic figuring, that the reflector came into general use. His instruments, even now, may be regarded as examples of first-class workmanship.

Sir William Herschel began making specula in 1774 and constructed a large number of reflecting telescopes, the most famous being his instrument at Slough of 4ft. aperture and 40ft. focal length; this was completed in 1789. Unfortunately the weight (25 cwt.) of the large speculum rendered it liable to distortion and it is of interest to note that all Herschel's discoveries were made with smaller instruments. More than fifty years later a reflector of 6ft. aperture and 54ft. focal length was erected by Lord Rosse at Parsonstown. All these instruments were fitted with metal mirrors which had an unfortunate tendency to tarnish, and repolishing was apt to spoil the figuring of the mirror. In the modern instrument the metal mirror is replaced by glass which can be re-silvered at intervals. During the last few years aluminium has taken the place of silver as the reflecting surface, the aluminium being deposited on the glass surface under vacuum. The aluminium film does not tarnish, is more robust than silver, and has a higher coefficient of reflection for short wave lengths, and is thus more efficient photographically.

Owing to the increasing demand for telescopes of higher magnification, and of increased light-gathering power, the size of the mirrors used in the modern instruments is steadily increasing. The Mount Wilson Observatory has a telescope with a mirror 100in. in diameter, and it is a matter of common knowledge that magnificent photographs of nebulæ, etc., have been obtained with it. At the present time an instrument having a mirror 200in. in diameter is being constructed for the Mount Palomar Observatory. The manufacture of the borosilicate glass (pyrex) block for this mirror, which weighs 20 tons, has been a feat of considerable skill, and if it is successfully ground and polished, as appears likely, it will be a great engineering triumph. It is difficult to realise the accuracy of grinding and polishing required in these large mirrors. Dr. Spencer Jones, the Astronomer Royal, has stated[5] that in the case of the "100 inch mirror, made at Mount Wilson, the actual curve of the glass nowhere differed from the correct theoretical curve by more than 0·000003 inch. The precision of figure required and attained can perhaps best be appreciated if expressed in this way: suppose the mirror to be enlarged 250,000 times so that the radius of curvature becomes about equal to the radius of the Earth—4000 miles. The diameter of the mirror would be about 400 miles and the mirror would easily cover England and Wales. The depth of its concave surface would be about five miles; the greatest difference between the paraboloid and the nearest spherical surface would be about 21 feet, and the largest divergence of the finished surface from a true paraboloid would be only about ¾-inch." We have become so accustomed to success in mounting and operating these large telescopes, that we are apt to forget that this is the heaviest and certainly the most impressive side of instrument construction work.

Thus, for the large telescope the reflector has established itself as the most satisfactory instrument, whereas for the smaller telescope, and for the everyday purposes of life, the refractor is still the more efficient. In 1733, Chester Moor Hall found that by combining lenses made from glasses having different refractive indices he was able to correct for the unequal refrangibility of light of different wave lengths, and succeeded in making lenses which produced images free from colour. The same discovery was made independently by John Dolland, who, in 1758, produced an achromatic telescope in which the object glass consisted of a convex lens of crown glass combined with a concave lens of flint glass. The invention of the achromatic lens must be considered as one of the milestones in the development of scientific instruments—its importance in nearly every piece of apparatus employing a lens can hardly be exaggerated.

THE SPECTROSCOPE

Perhaps there is no instrument which in recent times has aided pure science so much, and which is now beginning to help industry, as the spectroscope. Fraunhofer constructed the first spectroscope in 1817, and made the first measurements of the lines of the solar spectrum. He was also the first to observe the spectrum of the electric spark. In 1842, Becquerel and Draper independently photographed the solar spectrum on daguerreotype plates, thus laying the foundation for the modern science of spectroscopy.

In 1859, Kirchhoff showed that the luminous vapour of a metal has the property of absorbing the same kind of light as it emits at the same temperature. Kirchhoff recognised the fundamental importance of his discovery, entitling it "Spectrum Analysis"; but it is largely due to Hartley (1882) and later to Twyman who designed simple and efficient instruments, that spectroscopic analysis has become a quantitative method of chemical analysis. The spectrograph is now one of the most important tools in the metallurgical and chemical laboratory. In the manufacture of steel it is proving an invaluable check on the quality of the materials; the spectrogram obtained from the sample under test being compared with that taken from a standard. The speed of analysis may be judged from the statement[6] that it is possible for one man to analyse twelve samples of nickel - chromium - molybdenum steel spectrochemically for the elements silicon, manganese, nickel, chromium, molybdenum, vanadium, aluminium and copper in less than one day. The spectroscope has also become a tool in common use in the steel warehouse, the storekeeper being able by its means to detect any mixing of the batches of steels. In the laboratories of the works producing non-ferrous materials the spectroscope is proving equally efficient. For example, the failure of lead pipes from causes other than frost has been considerable, and has been traced to impurities in the lead. A spectroscopic examination of the pipe that has failed shows in a few minutes the undesirable impurities present, and, if the examination is carried further, the quantities of those impurities. There are few trades in which the spectroscope cannot be of service in testing the qualities of materials, etc.

Our knowledge of the constitution of the celestial bodies is almost entirely due to the spectroscope. By its means it has been possible to discover what elements are present in the vapour surrounding them. This was strikingly shown by the discovery by Lockyer, in 1868, of an unknown gas (Helium) in the bright-line spectrum of the sun's atmosphere, which was identified by Ramsay twenty-seven years later in the terrestrial atmosphere. The photographing of the sun's disc in a limited band of wave lengths has led to the development of a special form of recording spectroscope, the photo-spectroheliograph. In this instrument the slit of a spectroscope is slowly traversed across the sun's image, the selected radiation falling upon a photographic plate. Thus a picture of the sun is built up from a series of photographs taken in the selected wave lengths. For example, if the wave length selected is one of calcium, a picture of the disc is obtained showing the distribution of calcium over the sun's surface. In order that the photograph should not be striated, it is essential that the movement of the spectroscope across the sun's image should be uniform. Horace Darwin obtained this result by mounting the carriage of the instrument geometrically on large balls and by moving it by a falling weight controlled by an oil cylinder. The result was a triumph of simple geometric design. The major part of the knowledge obtained about the double stars and also the determination of the velocity of stars in the line of sight has been obtained from spectroscopic observations. The theory of the expanding universe may be said to rest on spectroscopic observations.

In theoretical physics the value of spectroscopic work cannot be exaggerated; it is, I understand, true to say that modern theories of atomic structure depend largely on evidence supplied by the spectroscope. Unfortunately there is no time to dwell on the comparatively new development of the X-ray spectroscope and the importance of this instrument in chemical analysis and in the understanding of the structure and behaviour of alloys.

DIVIDING ENGINES

The distinction between the telescope suitably mounted to survey the heavens and that used to measure distances upon the earth's surface is a faint one. The transit instrument is in general only a larger form of theodolite. The early surveyors (and here we may go back to early Egyptian times) made plans by means of rods and plummets; but it was not until the invention of the astrolabe and the use of a divided circle fitted with sights that accurate surveying was attempted. The first mention of the word "theodolite" occurs in a book *Pantometria* (1571) by an Englishman, Thomas Digges. (It is a matter of interest that Digges has some claim to be called "the inventor of the telescope.") The early theodolites, like the astronomical instruments, were fitted with pin-hole sights: in the case of the latter instruments an important controversy arose between Hooke and Hevelius (1679) concerning the relative advantages of telescopic and open sights. Although Hevelius was not convinced, the telescopic sight was almost invariably used after that date. Mention should be made that William Gascoigne invented the filar micrometer and fitted it to a telescope in 1640: this invention greatly increased the accuracy of instruments to which it was attached. Bradley's observation in 1722 shows that he used a form of filar micrometer with considerable success.

As the demands of the astronomer (and later of the surveyor) increased, so the need for improved divided circles became more urgent. The accurate dividing of circles has always been one of the more difficult tasks of the instrument maker, and it is almost entirely due to the English manufacturer that the art of dividing has reached its present high position. For many years there was no alternative but patiently to bisect, or trisect, with a beam compass the spaces set out on the scale or circle, and to continue this operation until the scale was subdivided to the desired number of divisions. The master points controlling the dividing can even now be seen on some of the old instruments. The names of George Graham (1673–1751) and John Bird (1709–1776) may be mentioned as masters of the art: it is stated that Bird was able to obtain an accuracy of 5 minutes of arc on his 8-ft. quadrant by continued bisection of the arc.

Henry Hindley of York, about 1739, completed a small machine for cutting the teeth in clock wheels and for dividing instruments. In 1766 Jesse Ramsden made his first circular dividing engine, but as it was not sufficiently accurate for dividing the scales of nautical instruments, he completed a second machine in 1775. As this was the pioneer of the modern dividing machine, it may be of interest to describe it in some little detail. The machine is now in the United States National Museum at Washington.

It consists of a horizontal wheel or plate 45in. in diameter, which turns on a vertical axis The periphery of the wheel is cut or notched into 2160 teeth, into which a worm meshes. Immense care was taken over the cutting of the teeth. The wheel was first divided into five parts, and each of these into three; these parts were then in turn bisected four times: this gave spaces corresponding to 432, 144, 72, 36, 18, and 9 teeth. These in turn were checked with another circle divided by continual bisections. The downward stroke of a treadle turned the screw forward a definite amount as determined by suitable mechanism. The circle to be cut was centred and fixed to the master plate, and after each stroke of the treadle a division was cut by hand, the cutting point being carried in a frame which would allow of linear motion only. One forward revolution of the screw advanced the plate through 10 minutes of arc.

(It was with this machine that Ramsden divided the circles of the 3-ft. theodolites used in the principal triangulation of Great Britain and Ireland, 1792–1862. They were divided to 10 minutes and read to one second by three micrometer microscopes.)

In 1826, William Simms invented the self-acting mechanism by means of which the dividing machine became completely automatic, thus saving an immense amount of time, and reducing the risk of error in the dividing of a circle. A similar but larger machine, built by G. W. Watts in 1905, is capable of dividing a circle 4ft. 6in. in diameter to 30 seconds of arc with an error not exceeding ± 1 second.

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[4] The actual observation reads:
"1722
"Dec. 27. 5 h. the distance between the horns of Venus was observed 29 rev. = 57·8 in a telescope of 212¼ f.—m. diam. 19.04″."
The Miscellaneous Works and Correspondence of the Rev. James Bradley, p. 354.

[5] *Journal of Scientific Instruments*, XII, p. 39 (1935).

[6] F. G. Barker, "Some Applications of the Spectrograph to the Quantitative Analysis of Ferrous and Non-ferrous Metals," *Journal of the Iron and Steel Institute*, 139, p. 244 (1939).

Linear scales are automatically divided by somewhat similar machines in which are fitted a temperature compensation device for variation in the temperature of the machine and a compensation device for correcting for any variations in the pitch of the master screw. In this connection the scientific man and the instrument maker are alike indebted to the late Dr. C. Guillaume for the invention of " invar," a nickel-steel alloy having a remarkably small temperature coefficient of expansion, and hence an almost ideal material from which to manufacture standard scales and measuring tapes. In the case of linear scales the position of the lines in a good metre scale can be guaranteed to an accuracy of 0·002 mm.

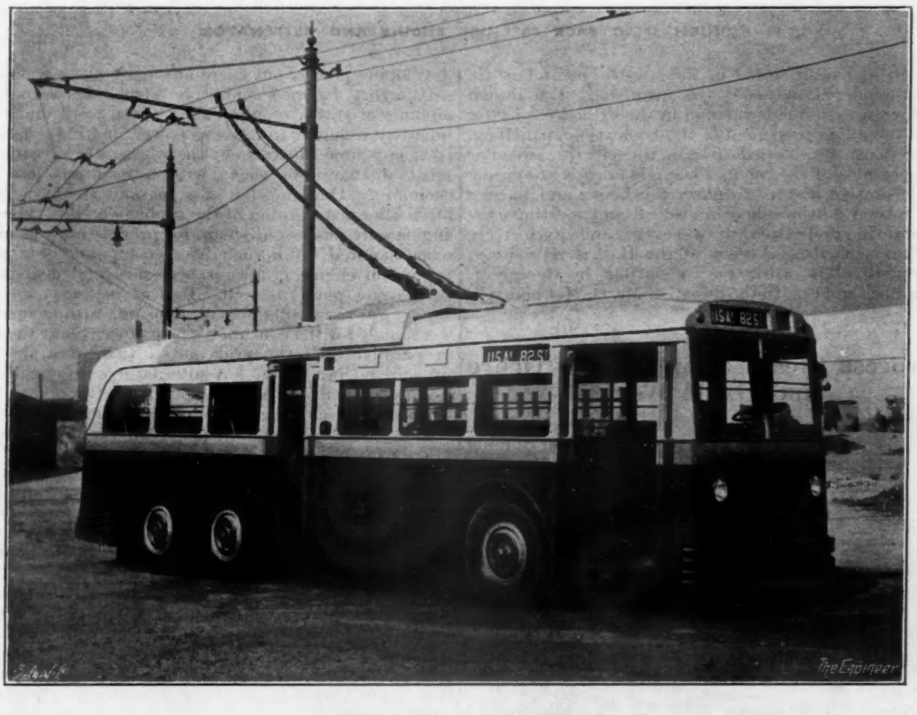
(To be continued)

Trolleybuses for Edmonton, Canada

Three six-wheeled single-deck trolleybuses, manufactured by the Associated Equipment Company, Ltd., of Southall, Middlesex, are shortly to be placed in service in Edmonton, Canada, on the city's Radial Railway. The vehicles are equipped with electrical gear made by the English Electric Company, Ltd., Edmonton, and will be the third city in Canada to replace trams by trolleybuses, the other two being Winnipeg and Montreal. In Montreal A.E.C.-English Electric vehicles are already in service.

In an accompanying engraving one of the new vehicles is shown on test at the makers' test track at Southall. The design largely follows the lines of the vehicles operated in Montreal, particularly in the inclusion of rear-mounted control equipment.

The severe climatic conditions of Edmonton, where temperatures 20–40 deg. Fah. below zero are not uncommon, and the hilly conditions prevailing have necessitated the provision, amongst other equipment, of sanding apparatus. For this purpose Kenworthy gravity feed equipment, operated electro-pneumatically, is mounted in front of and behind all the driving wheels. Another engraving reproduced herewith shows the driver's cab, in which in addition to the usual equipment, are mounted the sanding gear control and electric heaters.



TROLLEYBUS FOR CANADA

Of nickel steel, the chassis frame has a dropped front extension at the right in order to accommodate a front passenger entrance, and is rigidly cross-braced to carry a front bumper bar. In order to reduce the steering effort a special design of tapered roller thrust bearing is fitted to the swivel pins of the front axle.

Casings for the rear axles are made from one-piece nickel-steel stampings, which carry worm reduction gears in separate detachable housings, each having a capacity of two gallons of lubricating oil. The arrangement is such that the axles can be replenished with oil and the levels checked without entering the lower saloon and the worm gearing and differentials can readily be detached from the housings. A fully floating axle arrangement is adopted. The rear axle ratio is 10½ to 1, and the two rear axles are at 4ft. 4in. centres, so as to give extra clearance between the rear wheels for fitting snow chains, when required.

A combined reservoir and control unit is used for the air braking equipment, an arrangement to which reference has previously been made in these columns, enabling a material reduction to be made in the number of working parts, and simplifying the arrangement of piping and connections. Air is maintained at a pressure of 85 lb. per square inch by a twin-cylinder air compressor unit with a capacity of 5 cubic feet per minute, driven by a 1 H.P. motor operating at 500 volts. On the front axle the brake cylinders are mounted directly over the king pins. All six wheels are provided with air-operated brakes of the internally expanding pattern operated by a pedal supplemented by a hand brake acting on the rear wheels independently of the air system.

The Engineer

DRIVER'S CAB

For propulsion a 115 H.P. English Electric motor is mounted centrally on " Floatex " rubber suspension units from a tubular sub-frame and cross members, and, as previously mentioned, the electrical control equipment is housed at the rear of the frame in the form of a complete unit, access being gained to it through doors in the rear panelling.

Of all-metal construction, the body is designed to seat 38 passengers and is of English Electric manufacture. It is provided with entrances at the front and rear. All the frame members have been treated with linseed oil and varnish as a measure of protection against corrosion, and the skin thus formed is covered with ferro-graphite paint for additional protection. Following Canadian practice, both entrances are provided with double jack-knife folding doors framed in ash, the front door being pneumatically operated from the driver's seat, and the centre door by means of a treadle step. The spaces between roof and ceiling and between interior and exterior panels are packed with " Alfol " as a means of insulation. For ventilation there are six " Air-Vac " ventilators in the roof, two of the intake and four of the extraction type.

Since these trolleybuses will work in exceptionally cold conditions, particular attention has been paid to interior heating equipment. Twenty " Torribar " electric heaters are installed, eighteen beneath the passenger seats and two in the cab, under the control of the driver. Each element is rated at 100 volts, 250 watts, and two elements are incorporated in each heater, but are wired separately. To prevent the formation of frost the windscreen is provided with two heaters rated at 200 volts, 125 watts each.

Electric lighting and auxiliary equipment is of a comprehensive nature. Current is supplied by a 30-volt generator to a battery and a three-position rotary switch with " main," " emergency," and " off " positions, is connected to the supply. For the passenger saloon interior there are twelve ceiling lamps on each side and in addition there are guarded step lights for the two entrances, which are automatically switched off when the doors are closed.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FORCES IN THE LOCOMOTIVE

Sir,—The remarkably illustrative exposition of the various aspects of this matter appearing in the extracts from the Indian " Pacifics " Report in The Engineer of 21st and 28th July are particularly interesting to the writer especially in their dealing with the guidance of locomotives by bogies and of the controlling force which should be present at the bogie or pony track—and also at rear-trucks when such form part of the design—because of their concurrence with his experience in designs for extremely curved lines, such as those commonly found on what are termed " mountain " railways. At the same time there are certain comments which it is desired to make, not in criticism but rather in amplification, of what appears in the report.

It is stated, in relation to the necessity of decreasing flange forces at the leading coupled wheels, that the ideal " value to be aimed at is zero when the engine is running on straight track. On curves this cannot be attained." This latter is an under statement—in respect to engines with *four*-wheeled bogies—because as regards the effects to be attained on curves, it is quite possible to avoid all wear at the flanges of the leading coupled wheels, and that this is a *practicable* attainment is proved by the many locomotives of 4–8–0 type which have been placed upon a considerable number of severely curved railways abroad by the writer—and others—in which no flange whatever is placed upon the leading coupled wheel tyres; over 100 of such engines having been running for some years—and upon curves as sharp as 3 chains radius. With two-wheeled leading pony trucks, of course, a similar solution is impracticable.

It is, of course, possible to suppose a combination of curve and high relative speed in which the amount of lateral reaction required from the guiding wheels even of a bogie would be greater than the vertical pressure upon the rail-heads would allow of; but such combination could only be brought about by a very abnormal condition indeed, that is to say an engine driven into a curve at a speed totally disregarding the characteristics of the curve.

In respect to the particular matter of side control upon the leading bogie or pony-truck the writer cannot understand why more use is not made of three point " heart-shaped " swing hangers. These provide both an accurately determinable resistance which is not subject to alteration by broken control springs or other unforseen irregularities (such as weakened or unequally balanced control springs being mistakenly replaced during repairs) and, above all, add the very considerable advantage that whilst providing the necessary lateral resistance on the curves it holds locomotives 100 per cent. steady at the front and when on straight track; with three point links the lateral parallelism between the engine and the bogie is consistently maintained.

A further very important advantage of the swing-link bogie—also present to a lesser extent with two point links—is the automatic action in providing extra weight upon the bogie (or pony-truck) wheels when the guiding effect is required on curves. It has been sometimes supposed that a countervailing disadvantage to this increased proportion of weight upon the bogie when on curves has been the diminution of the adhesive weight, but this is not so in practice because on curves where the transference of weight comes into operation the engine is moving and the full amount of adhesion is not required.

In regard to bogie control it is to be noted respecting one of the American built Pacifics—a four-cylinder compound—although its condition was not first rate at the time of the test runs, it appears that although it rode roughly, "there was no tendency for oscillation to build up," and it would be interesting to ascertain whether those particular engines have Adams-type bogies with spring-control or are fitted with bogies of swing-link type; also whether they have given similar trouble in track distortion, &c., as have the other Pacifics. P. C. Dewhurst.

Montevideo, August, 1939.

INTERNAL COMBUSTION TURBINES

Sir,—In the letters which you were good enough to publish from me on "The Future of the Oil Engine," I suggested that engineers should recognise that for large powers the oil engine was doomed, in fact that it did not deserve to live, and that their attention should be drawn to the development of the internal combustion turbine as a means of obtaining larger powers in a smaller compass both in weight and space. The first problem to be solved in my opinion is the provision of an efficient rotary air compressor capable of compressing air to 100 lb. pressure and a capacity of from 2500 cubic feet of free air per minute and upwards according to the power of turbine required. No such rotary air compressor so far as I am aware exists to-day.

The axial flow blower or compressor made by Messrs. Brown Boveri and Co. seems to be only suitable for pressures of 5 to 10 lb. and is incapable of dealing with the heavier fuels which a turbine should utilise to obtain the greatest economy.

The rotary compressor should preferably compress at a single stage without inter-cooling so that the increased air temperature due to compression should render the combustion more efficient and so reduce the consumption of fuel.

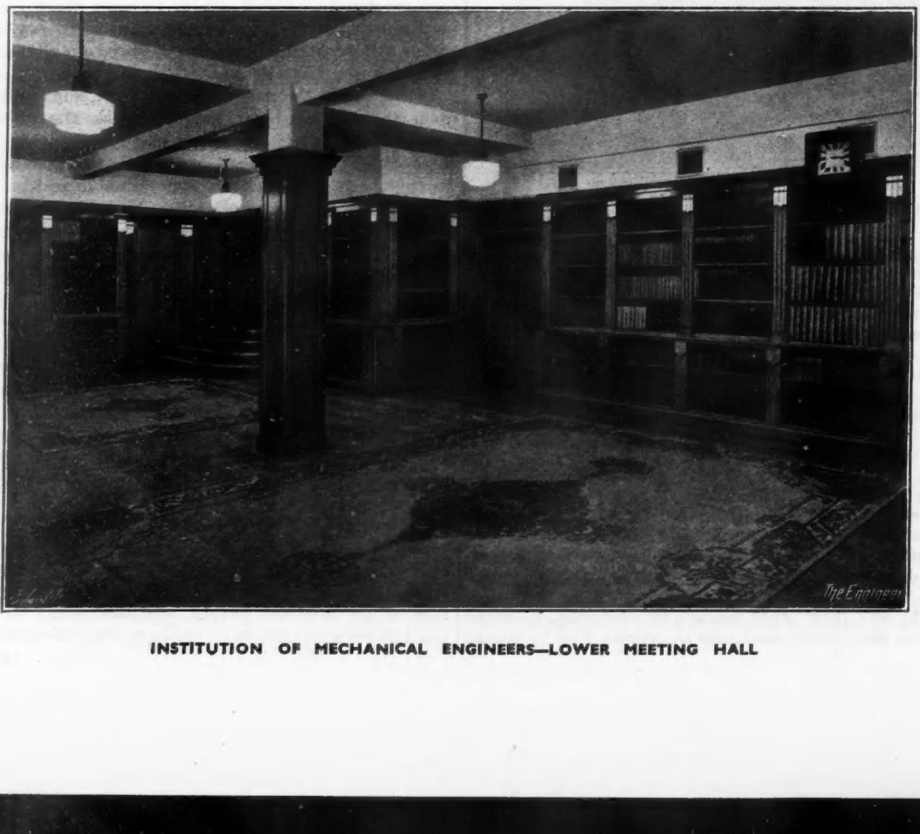
Some may think the reciprocating air compressor with its high efficiency should be sufficient but its weight, space and cost in the sizes required rule it out.

The provision of the rotary air compressor is in my opinion more important than the provision of heat resisting steels for the turbine blades because steel can be obtained to withstand successfully temperatures of 1000 deg. Cent. and even if this steel is incapable of resisting such a temperature for long periods there are methods of cooling the gases before entering the turbine chamber so as to prevent or obviate trouble. Hugh Campbell.

Blackburn, 12th Sept., 1939.

Institution of Mechanical Engineers

A few years ago at the instance of Major-General A. E. Davidson the Lower Meeting Hall of the Institution of Mechanical Engineers was constructed out of what had been a storage room for the stock of Proceedings. The Hall has proved of great service for Informal Meetings, the smaller meetings of kindred societies, and as an extension of the Tea Room when General Meetings are held in the Large Hall. More accommodation for library books being urgently required, it was decided to utilise the wall space afforded by the Lower Meeting Hall. As this room, with its plain distempered walls, did not conform to the style of the other rooms available for members, the Council approved a proposal to install oak panelling and book-cases. This alteration has now been carried out and has greatly improved the room, which may in future be further utilised as a Committee Room when the Council Chamber is occupied. The bookcases are being used to accommodate library sets of back numbers of periodicals which had been stored in the sub-basement but are now rendered accessible to members. The design follows a more modern trend in the orthodox pilaster and moulding treatment of the bookcasing, panelling, and doorways, varied in size to suit the irregular proportions of the room. The gilded caps are purely a decorative feature to offset the books and to give an intimate atmosphere for social and meeting purposes, in preference to a severe and exclusively Library scheme. A view of the Hall is reproduced herewith. The work was carried out by George M. Hammer and Co., to the design of Mr. G. H. Chantrell.

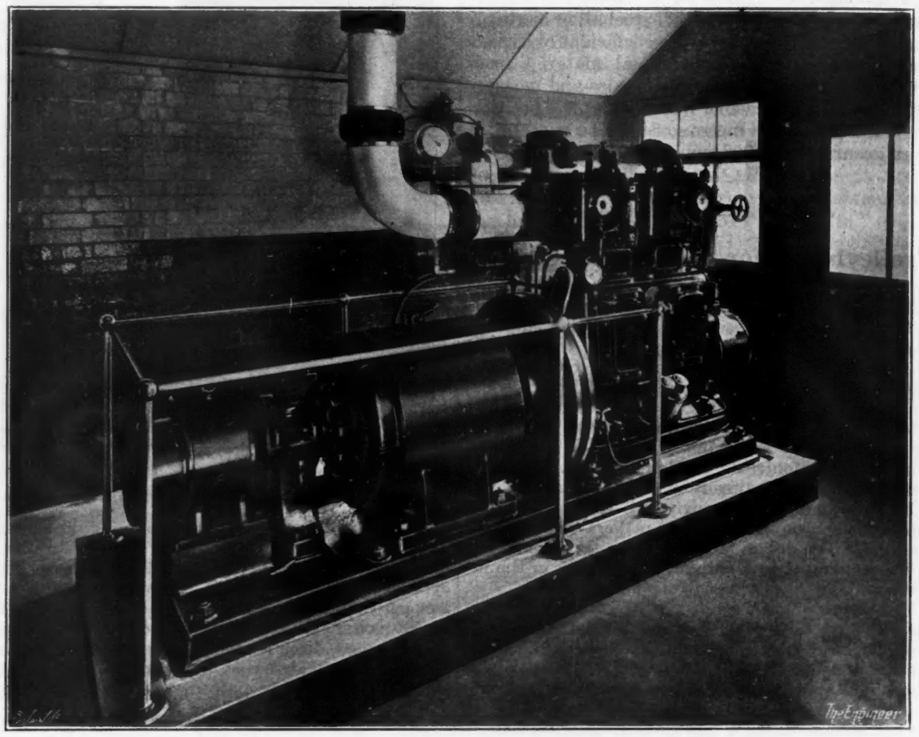


INSTITUTION OF MECHANICAL ENGINEERS—LOWER MEETING HALL

Process Steam Supply in an Ochre and Oxide Works

The illustration above shows a high-speed, back-pressure engine direct coupled to an alternator running in parallel with the grid, the load developed by the set being determined by the demand for process steam in the works at any particular moment. It was supplied by Ashworth and Parker, Ltd., of Bury, to the Golden Valley Ochre and Oxide Company (Yate), near Bristol, and is arranged according to the specification of Mr. George T. Champion, Consulting Engineer, Bristol.

It is a well-known fact that power can very economically be produced by process steam by first passing it through a back-pressure steam engine before utilising the steam in the works. Where all the steam so exhausted can be absorbed this arrangement is perhaps the cheapest possible method of developing power, but there are many cases where a satisfactory balance cannot be struck between the amount of steam required for process work and the quantity required to develop power, and if the latter is at any time in excess of the works steam requirements it blows to waste with a resultant loss in economy. The adoption of a pass-out steam engine often affords a solution of the problem as this type of engine only passes out steam for process work as and when required, but in such cases a compound or triple-expansion engine is always necessary and generally condensing plant as well. In this instance, as no water was available for condensing, arrangements were made for the consumer's new power plant to run in parallel with the grid and a two-crank, back-pressure engine and 26 kW alternator were installed. To meet the variations in the process steam demand a control gear was designed and fitted, which avoids the engine exhausting more steam than can be absorbed in the works.



HIGH SPEED BACK PRESSURE ENGINE AND ALTERNATOR

This special regulating gear, self-contained with the engine and requiring no outside supply of pressure water or oil for its operation, controls the steam admitted to the engine and consequently the load and the amount of steam exhausted to the process mains. The regulation is decided solely by the pressure in the process steam main. A slight drop in the pressure in the main owing to an increased demand for process steam will operate the regulator and admit more steam to the engine and vice versa. The operation is entirely automatic and whilst the load is being constantly varied to meet the fluctuation in process steam requirements the speed of the engine is maintained steady and in synchronisation with the Grid. The pressure in the process main is maintained within very close limits. When the engine is developing less power than the works requirements the balance is, of course, made up by the Grid supply. No difficulties, the firm states, arise in respect to synchronising. The main switchboard controlling the set was supplied by Veritys, Ltd., of Birmingham.

Engines for Gas or Oil Fuel.—A municipal light and power plant at Liberty, Texas, has been equipped with engines which can be converted for either oil or gas fuel. The engines are rated at 300 H.P. and are designed with cylinders 11½in. diameter by 13½in. stroke for gas fuel. When it is required to change over to oil fuel the cylinder liners are changed for liners 10½in. diameter. By changing the piston size compression is increased from about 100 lb. per square inch to about 400 lb. per square inch. The only other change that is made is in replacing the ignition system with injection nozzles which fit the sparking plug holes.

Rail and Road

The Motor Show and Commercial Motor Exhibition.—The Society of Motor Manufacturers and Traders, Limited, announce that neither the Motor Exhibition in October nor the Commercial Motor Transport Exhibition in November will now be held.

Workmen's Tickets and Air Raid Warnings.—The Minister of Transport has announced that in the event of an air raid warning signal being given during the time that holders of workmen's tickets are usually conveyed, those tickets will be available for issue for a period of twenty minutes from the sounding of the " all clear " signal. It has also been announced that, for the present, commercial travellers' day, overnight and week-end tickets will be continued as hitherto.

A Long Concrete Bridge.—What is claimed to be the longest concrete bridge span yet constructed is being built across the Angerman River in northern Sweden. It will be 264 metres long and will connect the western shore with Sandö Island in the river. A roadway from the bridge end will be continued, partly on viaducts, across the island and on over a girder bridge to the eastern shore of the river. The supporting form for the arch was built up of wood and floated into position on barges, which were sunk to lower it on the site. In order to prevent stoppage of river traffic whilst placing the form in position a new channel for shipping was dredged by the contractors.

Requisitioned Vehicles for Civil Defence.—The Ministry of Information announces that the Minister of Transport is in consultation with representatives of the road transport industry to fix the rates of payment for vehicles obtained for Civil Defence purposes. It is hoped that full information as to the payments to be made will soon be available. Meantime, in order to avoid any hardship, local authorities are authorised to make interim payments. The rates authorised for mechanically propelled vehicles vary from 10*s*. per week for those whose unladen weight does not exceed 1 ton to 30*s*. per week for those exceeding 5 tons. Public service vehicles are paid 40*s*. per week and taxicabs 50*s*. per week. Authorities also pay drivers' wages and petrol costs.

Closed Tube Stations in London.—A note from the Ministry of Information says that some misunderstanding exists regarding the closing of certain tube stations in London. The London Passenger Transport Board has been compelled to take certain safety precautions to eliminate the risk of any sudden flooding of the tunnels through the bursting of water mains or sewers where these pass through, or are adjacent to, the Board's stations. Certain protective works are temporary only, and careful review is being given to the execution of permanent works which may permit the reopening of some stations. Others will have to remain closed indefinitely. The Board, in conjunction with the Ministry of Transport, is examining the problems as quickly as possible and taking remedial action.

Mr. A. R. Trevithick.—We have to express our regret at the death of the last but one of the nine brothers who were born to Francis Trevithick, son and biographer of that great engineer Richard Trevithick—" Capt. Dick," of Redruth. Mr. Arthur Reginald Trevithick followed in the steps of his grandfather and for many years was associated with railway engineering. From 1906 to 1916 he was locomotive works manager of the old L. & N.W.Ry. and from the latter date till 1921 was carriage superintendent of the same company. He was a C.B.E. and M.Inst. C.E. His death occurred in his own county, Cornwall, at St. Ives on Thursday, Sept. 14th at the age of eighty-three. His son, Mr. R. E. Trevithick, carries on the family tradition; he is one of the directors of the La Mont Steam Generator Co. and a member of the Institutions of " Civil " and " Mechanical " engineers.

Heavy Rail Economy.—A sub-committee of the American Railway Engineering Association has presented a report on the effect on track labour costs by the installation of heavier rails. The investigation covered 39 railways in the United States and Canada having a combined total mileage of 226,000. It is stated that experience has shown that under average main line conditions the life of the heavy rail is greater than that of the light, the length of the increased life being dependent upon a number of factors. One of the railways under review based its decision to install 130-lb. rail in place of 100-lb. on the annual capitalised cost of the rail and ignored possible savings in track labour. On a district having a traffic of 23 million gross tons per mile of track per year, it was calculated that, since the 100-lb. rail had an average life of 5½ years, the 130-lb. section would have to last 8½ years, or 55 per cent. longer, to equalise the cost. As a matter of record, the 130-lb. rail has now been in service for 9 years with no removals and the minimum life will be at least 10 years, with the average considerably more. The saving in track labour ranged from 20 to 60 per cent.

Lorry Equipped with Wireless.—A lorry engaged in conveying mail from Marree to Birdsville in Australia has been fitted with a wireless transmitter with a range of over 600 miles. The lorry, a six-wheeled Cub, made by Leyland Motors Ltd., encounters in each trip not only arid deserts and 100 foot sandhills but also floods and swamps. Owing to the effects of floodwaters the route the lorry takes is frequently altered. The primary purpose, therefore, of the wireless transmitter is to maintain communication between the lorry and its base depot so that should it become bogged in swamp or stranded for some reason among the sandhills the driver can make known its state and guide a relief squad to his position. Before the lorry was introduced to the service camels carried the mail to Birdsville, and the journey, according to the conditions encountered, sometimes took a month or more. The lorry reduced the time to three days but owing to stranding it was occasionally " lost " for some days until the wireless equipment was installed. The transmitter measures 10 inches by 8 inches by 8 inches and weighs 10 pounds. It derives its power from the lorry's batteries. A secondary use has been found for it in that the mailman is able to advise persons on the route in advance on what day he expects to reach their mail boxes.

Miscellanea

Accidents in Mines.—During the four weeks ended August 12th last, 54 persons were killed and 200 seriously injured at mines under the Coal Mines Act, 1911.

Water Power.—A survey by the United States Department of the Interior shows that the ten countries leading in developed water power are as follows: United States, 17,949,000 H.P.; Canada, 8,191,000 H.P.; Italy, 6,000,000 H.P.; France, 5,400,000 H.P.; Japan, 4,800,000 H.P.; Germany, 4,000,000 H.P.; Norway, 3,000,000 H.P.; Switzerland, 2,800,000 H.P.; Sweden, 2,200,000 H.P.; and U.S.S.R. 1,630,000 H.P.

Priority of Work.—The Minister of Supply has made an order, entitled the " Priority of Work Order, 1939," under which contractors and other persons will be required to give priority to certain work in accordance with orders issued by officers of the departments concerned. We understand that these orders will at present only cover the parts of industry in which definite difficulties are experienced in meeting essential supply requirements.

An Iron and Steel Industry for New Zealand.—As a result of favourable reports by investigators the New Zealand Government has decided to open an iron and steel industry in the Dominion. About three and a half years will be required to develop the scheme which will cost five million pounds. Sufficient coal of suitable quality is available and known deposits show that there is enough iron ore and iron sand to supply the industry for at least fifty years.

Direct Hydrogenation of Coal Experiments.—In a joint report of the South Manchurian Railways and the Japanese Admiralty it is stated that tests at Fushun in an experimental plant for the direct hydrogenation of coal, consisting in the action of hydrogen on a mixture of coal and mineral oil at high temperatures and pressures, have proved successful. Further investigations are to be made to reduce the cost of manufacture of the synthetic oils obtained.

D.C. Power Transmission.—Preliminary researches are to be carried out in the United States, in connection with the Bonneville power project, on the long distance transmission of power at high voltages by direct current. A grant has been made for the researches and for the construction of an experimental line if preliminary investigations warrant it. Engineers at Bonneville are convinced that direct current transmission will be simpler and constructional costs will be lower than in the case of alternating current transmission.

A New Coal Breaking Method.—A new pressure method of breaking coal is being experimented with in the United States. By this process a hole is first drilled and in it is inserted a rubber tube encased in a woven sheath. A hydraulic pump is coupled to the tube by a flexible hose and through it pressure is applied to the tube in the coal. The pump builds up a hydraulic pressure of about 2500 lb. per square inch. in a minute and with properly spaced holes this is sufficient to break up the coal. It is reported that the experiments carried out show promising commercial possibilities.

Sandbags and Heating Plants.—The Coal Utilisation Council's engineer in Scotland calls attention to the fact that the placing of sandbags round basements is sometimes done in such a way as to cut off completely the supply of combustion air for hand-fired boilers or mechanical stokers. He has already had several cases brought to his attention in which fires have gone out through air starvation, and there will probably be many more when central heating plants are put into general operation. It is suggested that members of the coal trade, most of whom are doing A.R.P. work in their own areas, might take note of this danger; and, by a little timely advice now, prevent numerous complaints and considerable trouble when the cold weather sets in.

The Building Centre.—Owing to the present situation some of the activities at the Building Centre must necessarily be suspended. Until further notice there will be a skeleton staff in charge of the Bond Street building and such information as may be required will be given to inquirers. Exhibits will be maintained in as satisfactory condition as possible and the interests of the exhibitors will be closely watched. The full records of exhibitors' products and manufactures generally will be operated by some of the technical staff from a Government Department dealing with supplies, so that the very extensive technical data which the Building Centre possesses and the information which it has accrued on behalf of its exhibitors will be put into the fullest use possible during the war. As soon as circumstances allow the Building Centre will take up its usual course of work. In the meantime the Directors feel sure that if, in some circumstances, the full service which the Building Centre has been able to render to its exhibitors in the past is not in full operation every indulgence will be accorded. Until further notice the Building Centre will be open from 10 a.m. to 4 p.m. (Saturdays, 1 p.m.).

Coal Utilisation Council and the War.—It has been decided that the technical work carried out by the combustion engineers at the various branches of the Coal Utilisation Council—particularly their service of advice and assistance to consumers to ensure the utmost economy and efficiency in the use of fuel—shall be continued for the present as far as circumstances permit. The publicity and propaganda work of the Council is being discontinued and the activities of Area Committees will also be suspended. The National Coal Convention has been cancelled, but the Sales Training Courses will be continued, including the Continuation Course, of which a new series will start on October 1st. The written examinations, however, are temporarily suspended. Several of the head office staff have already been called up for military service or for work under the Mines Department, and the head office at Grosvenor Gardens House, London, will shortly be closed. For the present, however, communications may be addressed there to the Secretary, Mr. J. S. Williams, who is in administrative control of the skeleton staff. A further announcement will be made shortly as to his address after the closure of the present head office.

Air and Water

Panama Canal Traffic.—During the year ended June 30th last 5,903 ocean going merchant vessels passed through the Panama Canal.

Shipping on the Suez Canal.—During the first six months of this year 17,022,000 gross register tons of shipping passed through the Suez Canal. Of this tonnage 50·7 per cent. was British.

Engineer's Appointment at Aberdeen.—It is announced that Mr. John Anderson, assistant engineer in the chief engineer's department of the Port of London Authority, has been appointed senior engineering assistant to the harbour engineer at Aberdeen.

Empire Air Services.—A revised schedule of Empire air services announced by Imperial Airways states that, until further notice, there will be bi-weekly services between this country and Australia and weekly services to South Africa and East Africa. Air mail without surcharge has been suspended.

Montreal Harbour Improvements.—In addition to works involving an expenditure of over £100,000 already in hand, new works at an estimated cost of £60,000 have been started in Montreal Harbour. Improvement works now proceeding around the harbour now represent a total expenditure of more than £200,000.

Institution of Naval Architects.—The Council of the Institution of Naval Architects has made the following awards: Martell Scholarship in Naval Architecture (1939) to Mr. Norman W. Honey, of H.M. Dockyard, Sheerness. The Scholarship is of the value of £130 per annum, and will be held at the Royal Naval College, Greenwich. Earl of Durham Prize to Mr. Peter E. Bish, of H.M. Dockyard, Devonport.

Swedish Shipyard Extensions.—A new ship under construction at the works of the Kockum shipyard at Malmoe will be large enough to take vessels up to 22,700 tons. It will probably be completed by December next and will enable the company to tender for the construction of the two large warships for the Swedish coastal defence for which about 74 million kroner was voted by the Riksnag this year.

Herbert Akroyd Stuart Award.—The Council of the Institute of Marine Engineers has awarded to Mr. S. N. Mukerji, of Calcutta, the prize of £50 available every two years under the will of the late Herbert Akroyd Stuart for the best essay on " The History and Development of Heavy Oil Engines." Mr. Mukerji's essay will be published in the November issue of the Institute's Transactions. The next competition will close on April 30th, 1941.

The Tanker Pool.—The suspension is announced of the Tanker Pool, which was formed to regulate the supply of tanker tonnage by the maintenance of a fund, derived from a levy upon freight earnings, out of which owners who laid up their vessels when freights were below economic levels received compensation. A majority of tanker owners participated in the pool and it has been suspended because the demand for tankers at remunerative rates will obviously increase in the near future.

Shipbuilding in America.—According to the *Journal of Commerce* orders have been placed in the United States during the past few weeks for 17 large merchant ships. Up to date this year orders placed comprise 35 large vessels, including 23 cargo vessels, 2 tankers and 10 passenger-cargo vessels. The orders already placed this year will be augmented during the coming months by orders for additional vessels, as part of the Maritime Commission's programme of 50 new ships a year for 10 years.

Death of Mr. George Nicol.—It is with regret that we note the death of Mr. George Nicol, the Glasgow naval architect who was a surveyor to Lloyd's Register of Shipping for more than thirty years. He was particularly well known for his books, two of which were " Ship Construction and Calculations " and " Ship Stability." Before serving on Lloyd's Register he had served on the designing staff of Swan Hunter and Wigham Richardson Limited and was manager and estimator to the Northumberland Shipbuilding Company.

Reservations at Port of Pembroke.—The Admiralty has announced a reservation in the dock yard, port of Pembroke, of an area in which anchoring and passing will be prohibited. It comes into force after twenty-one days from September 11th, after which no vessel may contravene the prohibition unless compelled to do so by stress of weather or to avoid accident; nor when the area may be uncovered or nearly uncovered at low water may any person pass through or remain in it unless by permission or under arrangements made by the officer in charge.

Board of Trade Examinations.—The Board of Trade announced in June last that a new system of examination for Certificates of Competency as Engineers in the Mercantile Marine would come into operation in September, 1939, but that until further notice the existing system of examination would also be continued. This arrangement was made so that the new system might be brought into operation with a minimum amount of interference with the arrangements of candidates and of the schools concerned. The number of candidates under the old system is now small and the Board has decided that on and from January 1st, 1940, these examinations shall be conducted under the new system only. Examinations under the old system will, therefore, cease at the end of 1939.

Tug Fitted with an Adjustable Propeller.—An oil engine propelled tug recently delivered in Sweden is equipped with an adjustable propeller. This type of propeller is known as the " Ka-Mé-Wa " and its design is based upon experience in building Kaplan water turbines at the A/B Karlstads Mekaniska Werkstad. It is the first propeller of its kind to be fitted to a tug-boat. Its design enables the blades to be adjusted to give any required propeller effect from full ahead to full astern. Full horsepower output from the engine is obtainable at any setting and this, coupled with the fact that propeller settings are controlled from the bridge, makes the equipment particularly advantageous for a tug-boat. Reports state that trials of the " Herkules," as the boat is named, have been very favourable.

PROJECTED MACHINE TOOL EXHIBITS AT OLYMPIA

(For description see page 307)

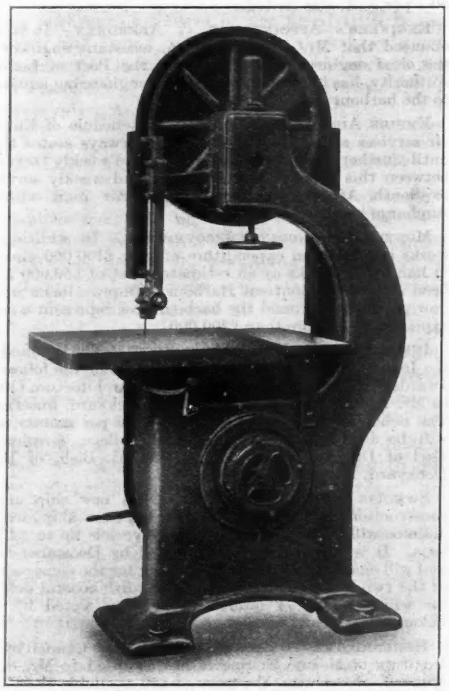


FIG. 45—24-INCH BAND SAW—DOMINION

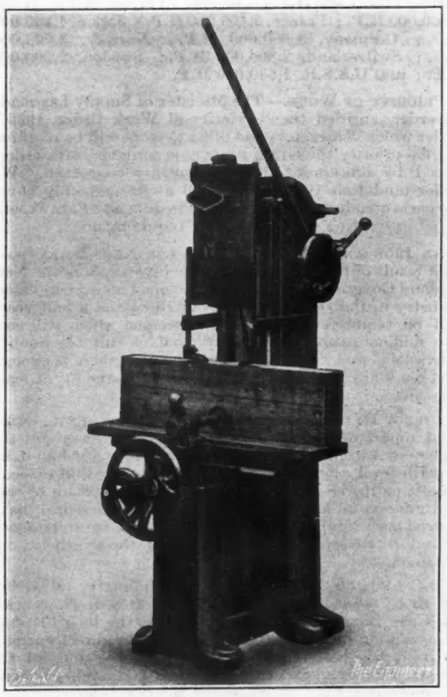

The Engineer

FIG. 46—HOLLOW CHISEL MORTISER—DOMINION

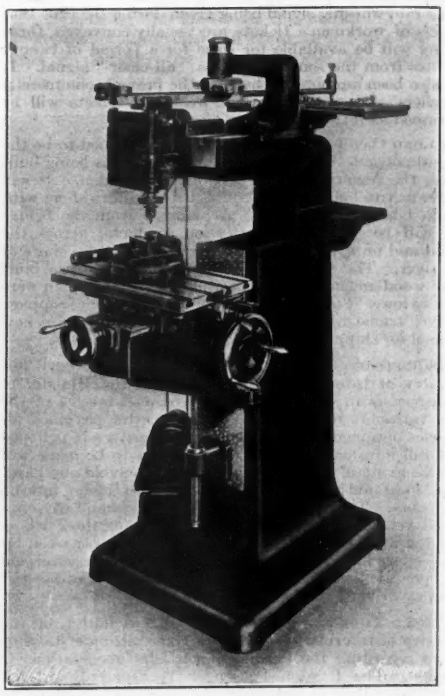

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FIG. 47—ENGRAVING MACHINE—JOYCE

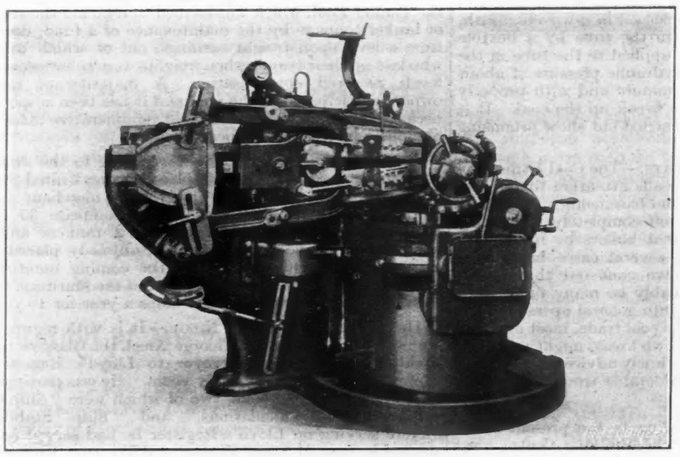
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FIG. 48—BEVEL GEAR GENERATOR—TURBINE GEARS

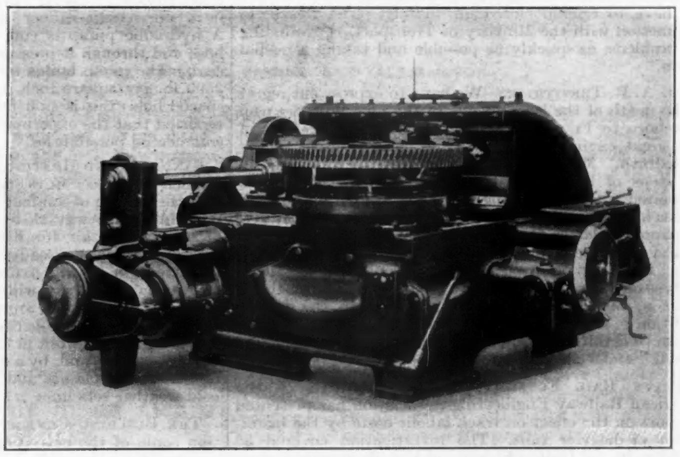

FIG. 49—WORM WHEEL GENERATOR—TURBINE GEARS

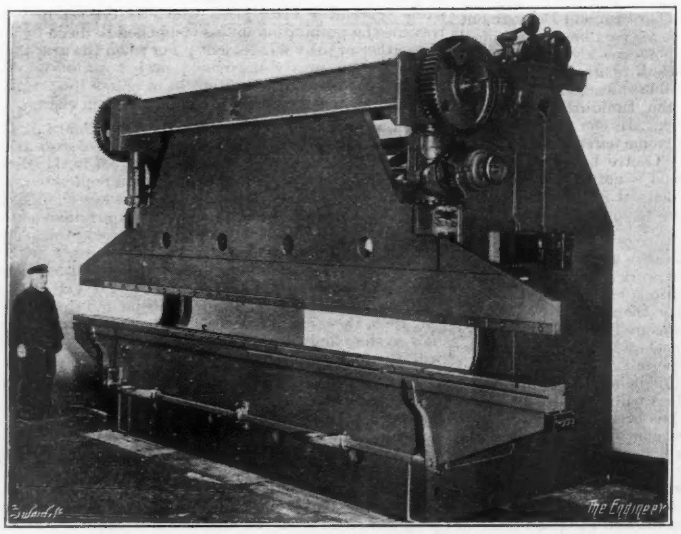
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FIG. 50—100-TON FOLDING PRESS—PELS

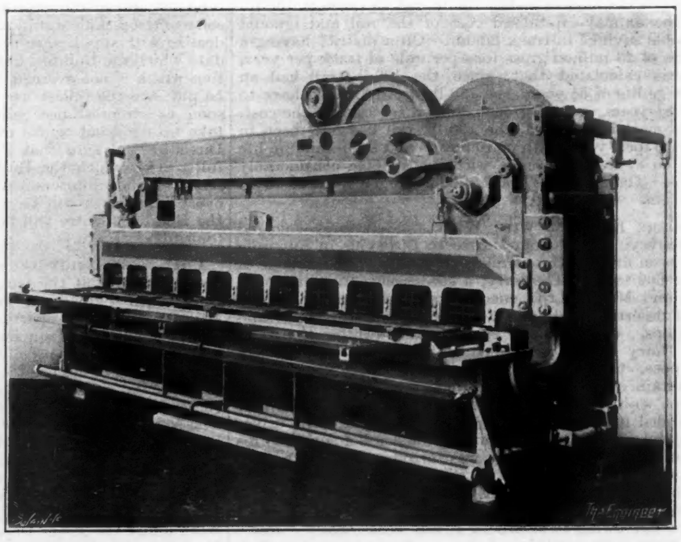
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FIG. 51—GUILLOTINE SHEARS—PELS

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*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address : "The Engineer," 28, Essex Street, Strand London, W.C.2.

Telegraphic Address : "Engineer Newspaper, Estrand, London."
Telephone : CEntral 6565 (10 lines).

DEATH

On September 18th, 1939, suddenly, at his home, 40, Woodville Gardens, Ealing, SYDNEY EVERSHED, aged 82.

INSTRUMENTS AND THE ENGINEER

AMONG advanced physicists the view is gaining increased adherence that the universe and all its alleged phenomena are merely matters of mathematics and that the nearest approach to a conception of reality which man can essay is represented by a mathematical formula. It is impossible, they say, to learn anything about the universe except by the ways of the mathematician. Experimental approach is forbidden because the very attempt to perform an experiment in any field alters the field in such a way and to such an extent as to invalidate the observed results. If this view is correct all experimentally determined facts are nothing but illusion or delusion; the picture of the universe impressed upon our senses is simply a vision, distorted and perhaps wholly imaginary, which is conjured up and coloured by the instruments employed for the study of natural phenomena. In short, the universe that we know is not the universe that exists but is that which we, with our assumed ability to interpret it, conceive it to be.

In a small way every engineer and physicist is familiar with, and admits the validity of, that argument. The conditions under which many electrical, hydraulic, and other experiments are performed are necessarily such that the factor to be measured is affected by the presence of the instrument employed for its measurement. The degree to which the presence of the instrument affects the recorded result is, or is assumed to be, in general so small as to have no significant effect upon it. The consideration herein involved may normally be regarded as one of experimental technique; the ultra-modern natural philosopher has magnified it and raised it to the status of an all-embracing fundamental doctrine. He may be right, but if he is he has reached the truth by a curiously involved route. All our knowledge of the universe is derived from experiment and with each refinement made in the instrumental equipment employed for experimental investigation an increase of knowledge has accrued. It is possible to believe that such increase of knowledge is really illusory and that it is actually the product of the increased refinement. On the other hand in many instances we have a general, well-defined feeling that our knowledge of natural phenomena is increasing in the direction of finality and is not characterised by an ever-growing divergency away from established beliefs. If that be so it would seem to tend strongly in favour of the experimental approach to an understanding of the universe and of a belief in the validity of instrumental ovservations. The history of the development of certain scientific instruments, presented by Mr. R. S. Whipple to Section A of the British Association, is full of reminders that at all stages in the development of science from the earliest days up to the present, the mathematician has been dependent upon experiments and instruments for the basis of his physical theories. Newton, through Kepler, depended upon the astronomical observations made by Tycho Brahe. Modern theories concerning the structure of the universe have, in a vital way, been influenced by the experimental facts obtained with the aid of the spectroscope. To deny the validity of instrumental observation at this late stage, to substitute for it an exclusive belief in the validity of pure thought would appear to be both irrational and ungrateful. We might almost liken it to the denial by a dweller in an upper storey of the existence of foundations to the building which he inhabits.

However it may be in physics, in engineering no one will belittle the share played by instrumental observations. How much of the progress made by our profession since the days of the pioneers is ascribable to the invention and development of instruments of ever-increasing precision few, except engineers, are able fully to realise. The need for them grows with each step forward. We are dependent upon them both in the manufacture of our products and for the investigation of their performances and defects after they have been made. An address as long again as Mr. Whipple's would be needed to cover even cursorily the use and significance of instruments in engineering practice. Outstanding above all other considerations would be the vital importance of instruments for the accurate division of a circle, or for measuring such division, for on our ability to construct and use such instruments we depend at almost every turn in civil, mechanical and electrical engineering. Without them surveying, the production of gearing and all gauging of dimensions would be impossible on the scale of accuracy demanded by modern conditions. Hardly less important than the division of the circle we would place means for the accurate measurement of temperature. Without such means many workshop processes, such as the thermal treatment of metals, could be performed only in a crude and primitive way, and practically all detailed testing of heat engines and their auxiliaries would be impossible. Engineers certainly recognise the debt which they owe to the instrument makers, often obscure and even forgotten as to their names, who have laboured and thought for the ultimate benefit of the profession in all its branches. It is not for us to question the validity of instrumental observations. Without instruments, or without an inviolable faith in them, engineers and engineering would cease to exist. We would revert to the level of the old-time village blacksmith and our calling would no longer have any claim to a scientific title.

Mechanical Instincts

IT might, we think, be said with no more than a little rhetorical inexactitude that fifty years ago every young mechanical engineer worth his salt invented a rotary engine, and sought to solve the problem of perpetual motion. In those days specialisation was hardly known. The mechanical engineer was expected to be capable of dealing with any appropriate subject, and to be also a competent mechanic. If he were a "gentleman apprentice," a title unknown to the present generation, he served his time in several shops. He learnt to cut patterns with his own two hands, and to mould them in sand; he spent several months on a lathe which had, as a rule, a personality of its own that had to be mastered with pain, often physical, and with tribulation of a kind which, under the foreman of the period, added to the 'prentice's vocabulary a selection of words and phrases that are the shibboleths of works. Then he had a turn in the fitting shop, where he learnt to chip and file—dying arts. "Chipping" was not the genteel business of the toolroom, with a graver's cold chisel and a four-ounce hammer, but honest slogging with a heavy head on a long springy haft swung well over the shoulder and brought down mightily on the chisel—or the ball of the thumb. After that, months were spent in the erecting shop, and with luck on outside work with an old hand. Erection was, of course, very different from what it is nowadays. Parts were not standardised, and the erector was expected to do a good deal of fitting, bedding-down bearings, cutting keyways, trimming off protruding edges, and so on. Then came a year or more in the drawing-office, and the completion of the indentures at the age of one and twenty. But practical training did not end there. Every young engineer was expected to do two or three years as an improver in works other than those in which he had served his time.

The result of this long practical training was that the young man was saturated with mechanical engineering. He knew the metals in common use intimately, what they could do, and what could be done with them; he had watched mechanisms being built up under his own eyes, and had helped in the building; he had seen machines put together and had witnessed successes and failures; he had had to exercise his ingenuity in devising means of circumventing the errors of the drawing-office, or the wilfulness of machine tools. And all the time he had worked cheek by jowl with a class of men from whom, if he were any good, he acquired things outside his ordinary ken. Moreover, he had learnt, if he were worth trusting, to rely upon himself and the art of directing the work of others. In fact, he became a man, as well as a mechanical engineer. The rapid sequence of events, pursuing each other toe to heel during the last twenty or thirty years, has inevitably undermined this kind of training. Apprenticeship is not what it was; it is impossible that it should be. A new system has been devised to meet new conditions, and it has the defects of its merits. We wonder sometimes if there are as many all-round mechanical engineers as there used to be. We mean men inspired by mechanical instincts; men who rejoice in mechanisms; who lose no opportunity of devising them; who can sit down pleasantly for a few hours of evenings to work out rotary engines with bits of cardboard, or puzzle their brains over the anomalies of perpetual motion. There is, we know, a school of thought which discourages such occupations—amongst students at least. It holds that mechanisms *quâ* mechanisms should not be taught in colleges. It has not, we believe, any objection to students making themselves familiar with such objective things as gearing, link motions of one kind and another, cams, rotary engines, and the whole battery of mechanical devices; but, in its opinion, lectures should be confined to fundamental principles and actual applications should be left for consideration till the world of affairs is reached. We wonder if this view is correct? Is it not possible that too much abstraction may lead to the atrophy of those mechanical instincts which are inherent in most boys, and should be well developed in all whose object is to become mechanical engineers?

That, we venture to suggest, is a rather important question. If it could be shown positively that abstract studies lead to mechanical inventions we should not have a word to say against their monopolisation of the field of studies. But can that be shown? Does the ability to solve mechanical problems propounded by someone else stimulate the power of invention? It seems unlikely. The course which one would expect would be first the act of imagination, the invention, and then the mathematical and scientific solution of such problems as it presents. That is, we say, what we should expect, but when we find that a great many of the devices adopted in Great Britain originated in countries where the mechanical instincts are not fostered as they used to be here, we are left in some doubt. That doubt will not be removed till we know the origin of the inventions we have in mind. Did the ideas come first from the practical men, or did the scientist and mathematician both propound the proposition and find the practical solution? If that, indeed, be what happens, things have changed enormously since the time when the British were the most inventive people in the world.

Obituary

W. H. TREWARTHA-JAMES

Mining engineers in many parts of the world will learn with regret of the death in London on Thursday, September 7th, of Mr. W. H. Trewartha-James, who was a member of the firm of James Brothers, Consulting Engineers, of Finsbury House, London, E.C.2, and was a founder member of the Institution of Mining and Metallurgy. Mr. James, who was born in Redruth in 1861, was trained at the Camborne School of Mines, and joined his father, the late Captain A. J. James, who was the manager of several Cornish mines. In 1880, Mr. Trewartha-James went to Venezuela, where for five years he acted as assistant manager of the New Quebrada Railway Land and Copper Company. In 1888 he went to South Africa and became the manager of the Moodies Gold Mines at Barberton in the Transvaal. In 1899 he was associated along with his brothers, Mr. Alfred James and Mr. Cordner-James in the introduction at Johannesburg of the Macarthur Forrest cyanide process for the recovery of gold from its ores, after which he introduced the same process to Mexico as manager of the Mexican Gold and Silver Recovery Company. For many years Mr. James devoted most of his time to the metallurgical problems which were associated with the development and progress of the cyanide recovery process, which eventually found world-wide adoption. For five years he acted as manager of the Tyee Copper Company in British Columbia. On taking up consulting work he visited many of the renowned mining centres of the world, including Canada and the Yukon, the United States of America, Mexico, Venezuela, Brazil, the Argentine, South and West Africa, Nigeria, and also France, Switzerland, Austria, and Western Australia, with which countries his firm was closely associated. From 1896 until the time of his death he represented his firm as consulting engineer to several gold mining companies in Australia. Mr. Trewartha-James had a wide circle of business friends and was widely esteemed as a mining engineer.

A.R.P. for Cupola Furnaces

The British Cast Iron Research Association has published a report on A.R.P. for Cupola Furnaces (price 2s.), and the following is a summary of its recommendations.

On receiving a warning of a raid, the blast should be shut off. The metal and slag should be drained from the well, poured down, and covered with sand. The metal tap hole should be closed but the slag hole may be left open. The cover plates on two tuyeres should be opened.

No cupola may be operated after dark unless equipped with complete anti-glare screening. At night no light or sparks may escape from the top of the stack, or the charging hole, even during the blowing down period. The tuyeres, tapping hole, and slaghole as well as the metal and slag must be screened and also the "drop" at the end of the melt. In certain conditions it is possible to obtain a Treasury grant towards the cost of anti-glare precautions.

Cupolas operated in daytime without anti-glare cowling may need to be "blacked out" during a dark period, in which case the condition of the top of the cupola should be noted, and if a large amount of flame and heat is present, charges of coke should be put on, followed by a mixture containing sand and limestone. Bars should be placed across the charging hole and steel plates put in position to close off the top of the cupola. Sand should be placed on top of the plates to a depth of 4in. to 6in., to prevent the heat from the cupola showing through.

It will be appreciated that the precautions recommended above are of a general character and it will be necessary for each firm to work out a routine for themselves. It is strongly recommended that the cupola squad should be drilled in taking these precautions, especially in the case of cupolas which will be operated after dark.

Each man should be thoroughly conversant with the duty allotted to him in the event of a raid, and in order that precautionary measures may be carried out as smoothly and as rapidly as possible, the whole procedure should be well rehearsed in advance and the workers should be well drilled beforehand in order to secure the maximum co-ordination of effort.

The Association will be pleased to consider any special foundry conditions not covered in the report. Comment and criticism will be welcomed and should be addressed to the Director. Comments or suggestions on the desirability of dealing with any other type of furnace will be appreciated.

Sixty Years Ago

The Steamship "Orient"

Modern marine improvements and luxuries are so numerous that we sometimes feel a high measure of respect for those who ventured on long voyages in days gone by. We can, however, easily mislead ourselves in this respect. It is certainly true that by 1879 ships were in existence which, if not in all respects as regards safety, at least as regards luxury, compared not unfavourably with the ships of to-day. Had we in the year mentioned been bent on a voyage to Australia, we would probably have elected to book our passage on The Orient Steam Navigation Company's new steamer "Orient," built on the Clyde by John Elder and Company. Only a few years previously we would have had to proceed by sailing ship for the trip was too long for any steamer to do it on the coal which she could carry from England. The "Great Eastern," it is true, was intended by Brunel to carry enough coal for the voyage out and home, but she was not a success commercially, and if a passenger to Australia desired to avoid using a sailing ship, he had for many years to use two steamers, and make a land journey across the Egyptian desert. Following the opening of the Suez Canal, Anderson, Anderson and Co., of London, chartered some vessels from the Pacific Steam Navigation Company and established a direct service to Australia. The experiment was a success and about 1877 the Orient Steam Navigation Company was formed to continue the service on a regular basis. The "Orient" was the first steamer especially designed and built for the new company. Her cost was about £150,000. Her displacement was 9500 tons, a figure which placed her next in size to the "Great Eastern" with 22,000 tons. She had an overall length of 460ft., a beam of about 46ft., and a depth to the main deck of 27ft. In her bunkers she could carry 3000 tons of coal and in her holds 3600 tons of cargo. An engraving of the ship, published in our issue of September 26th, 1879 shows that she had two funnels and four masts, fully rigged for sails. Accomodation was provided for 120 first-class passengers, 130 second-class and 300 third-class. The first-class dining saloon measured 44ft. square and extended across the full width of the hull. The passengers sat at two long tables in the centre of the saloon and at eight small side tables. Each first- and second-class cabin was fitted with a wash basin. Mechanical ventilation was fitted throughout the ship and punkas driven by machinery were provided in the first-class quarters. The sanitary arrangements, lavatories and bathrooms were constructed "on a scale and with a finish and elegance of detail unparalleled in a West-End club or a first-class hotel." There were two barber's shops and on the upper deck there was a music saloon equipped with an organ and a piano. The provision made for the safety of the ship included an extensive system of sub-division. The hull was divided into thirteen watertight compartments, four of which would have to be flooded simultaneously before the ship would sink. In addition there were fire bulkheads which divided the hull into six compartments. Eight boats were carried on davits on the main deck. The engines were three-cylinder compounds and indicated 5400 H.P.

A Windowless Factory*

The world's first windowless factory, whose construction was halted in 1931 by the depression, was finally completed and put into operation at Fitchburg, Mass., by the Simonds Saw and Steel Company, on June 28th, 1939. Everything from forging and heat-treating of steel to the sharpening and shipping of saws, machine knives, files, and other cutting tools, drafting, engineering, and office functions are carried out in the single 5-acre room, which has no partitions and is completely air conditioned. Operating two eight-hour shifts, five days a week, the plant assures each employee absolute uniformity of light at his job, regardless of the hour or weather conditions. More than fourteen thousand 100-watt fluorescent tubes provide a blanket of "cold" light over everything, shadows are eliminated, and the working plane receives from 20 to 25ft.-c. of shadowless light from all directions.

The atmosphere inside the plant is kept clear, cool, and comfortable despite the presence of some 700 heat-treating furnaces, more than a 1000 individual motor-driven grinders, cutters, and other machines which are in almost constant operation. The furnaces themselves are served by three underground flue-gas-exhaust systems with suction fans to exhaust gases directly outside from 63 different locations. While hundreds of emery wheels throw off sparks and dust in the grinding of saw teeth and knives, the air is kept clear of all such particles by 30 dust-removal units which filter the air and then recirculate it.

Large air-conditioning units in four building extensions adjoining the huge room circulate 400,000 cu. ft. of air per min. through 3000ft. of overhead ducts to provide five complete air changes per hour. Automatic controls are set to maintain maximum comfort, which is provided in the summer by blowing the air through sprays of water which flows at 52° F from four artesian wells next to the plant. Air is also forced directly from these units to "man coolers" which moderate the temperature around the furnaces and drive the warm air up into the curtained ceiling areas above them, where all used air is exhausted through 42 roof ventilators.

Four drop hammers, which forge the teeth for inserted-point saws, and similar equipment, are isolated by means of special foundations and shock-absorbing insulation, so that delicate precision-testing equipment in the metallurgical laboratory a few aisles away is not jarred. Walls of acoustic block and a cork-filled ceiling designed to absorb more than 90 per cent. of the sound have muffled the noise created by the metal-working activity to a point which enables the telephone switchboard operator and office employees to work without difficulty.

Another interesting innovation in this factory is a quarter-mile protected walkway, 4ft. wide, from which visitors will be able to see the entire plant and its various operations. All machines are painted a bright yellow, all furnaces and benches aluminium, all steel columns, stairs, and walkways green, and the ceiling a light cream. The building contains 17,000ft. of underfloor power ducts, 38,000ft. of piping, 60,500ft. of galvanized-iron conduit, and more than 30 miles of wire and cable. These lines carry power, light, water, gas, steam, and air directly to machine and furnace locations by passing above the building trusses, down the columns, and under the floor, leaving the working area clear of such obstructions. Push-button controls are practically universal and central control of process piping is provided in the individual bays. Electric power to meet the plant's connected load of 6000 H.P. is provided chiefly by the local public-utility company and supplemented by the output of three Diesel engines operating at an old building near-by.

With bulkier products being handled along the side farthest from the offices, there are eight self-contained production lines under one roof, each performing all the operations required to convert raw materials into finished products of a particular type under conditions conducive to efficiency and the required quality of product. Thus, each of the several thousand different types, sizes, and grades of saws, knives, and files made by the company moves in a straight line through the sequences of toothing, milling, hardening, grinding, polishing, and sharpening to finished stock bins and shipping platform.

American Machine Tool Show Cancelled

In view of the outbreak of the war in Europe, the members of the National Machine Tool Builders' Association have decided to postpone indefinitely the Machine Tool Show, which was to have been held at Cleveland, Ohio, on October 4th to 13th. This also involves the postponement of the Machine Tool Congress, a series of meetings which were sponsored by a group of nine engineering and technical societies, and which were to have been held during the Show. Mr. Whipp, President of the Association, says with regard to the postponement: "The members of the Association feel that the greatest contribution the industry can make to the welfare of the nation at this time is to concentrate their entire efforts on the production of the greatest possible number of machine tools. Under the circumstances, the industry and its customers cannot afford the time of their key men for a Machine Tool Show, and postponement is felt to be the wisest course. The immediate effect of the war is a quickened demand for all of the products of industry. While everyone is conscious of the demand for munitions, the embargo will eliminate that factor in the present situation. However, it has been estimated that munitions were only ten per cent. of our exports during the last world war, and the greatest burden by far that will fall on American industry is to furnish the normal needs of nations who have been trading with the countries now at war, and who can no longer be served by them. This great demand for goods of all kinds is reflected in the need for better machine tools since all manufacturing equipment is built on them."

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* Reprinted from *Mechanical Engineering*, Aug., 1939.

Projected Exhibits at Olympia

No. II

(Continued from page 289, Sept. 15th)

BELOW we continue our description of some of the exhibits which were to have been shown at the Engineering and Marine Exhibition at Olympia, London, the holding of which has had to be postponed on account of the war.

Dominion Machinery Company, Ltd.

A wide range of woodworking machinery would have been found on the stand of the Dominion Machinery Company, Ltd., of Hipperholme, Halifax. In Fig. 52 is illustrated a belt sanding machine, which the firm is now making in two sizes with tables 45in. by 12½in. and 45in. by 14½in. The main casting carrying the table is in one piece and it is bolted to two substantial cast legs. For tensioning purposes the bearings of the belt pulley at one end of the machine are mounted in slides integral with the main casting. The bearings at either end of the tensioning pulley move independently of each other in their slides, under control of hand screws. This arrangement permits either side of the belt to be taken up to eliminate the effects of side stretch. The table is also adjustable to permit the belt to be run tight or slack upon it. Drive from the motor is by a vee belt and slack in this can be taken up by sliding the motor along its mounting. By removing the guard and cover the machine is rapidly adapted for long work pieces.

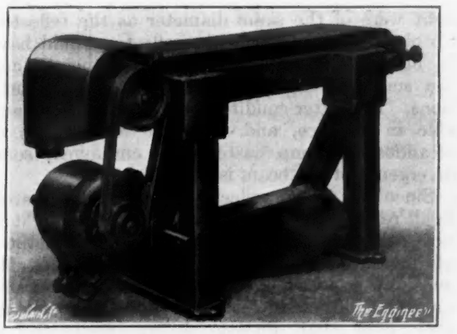

FIG. 52—BELT SANDER—DOMINION

A 24in. direct motor-driven band saw destined for the stand is shown by Fig. 45, p. 304. Its frame is a one-piece casting so cored out as best to distribute the material in order to eliminate vibration and ensure steady running. The 24in. diameter arm type wheels have a 1¾in. face, upon which rubber bands are vulcanised. The saw is effectively guarded, access to the bottom wheel being by means of a cast iron hinged door, and the top wheel is protected by a circular guard. A square guide post of steel may be clamped at any convenient point. The table is carried by a cradle and can be tilted and held rigid at any required angle up to 45 deg. A conveniently placed brake enables the driving wheel to be stopped almost instantaneously.

The " B.M." motor-driven hollow chisel morticer and borer (Fig. 46, p. 304) has been designed for stock up to 12in. by 8in. and for morticing up to ¾in. square. It has a one-piece box section cast body, on which the motor is mounted on vertical square guides. The auger is secured direct to the motor spindle and gives a direct and positive drive to the cutter chisel at 3000 r.p.m. A blower is built into the frame of the motor and gives a strong current of air down ducts cast in the hollow chisel bracket, to blow the chips away and cool the chisel and bit. In order to prevent the timber from being lifted as the chisel is being withdrawn, two vertical adjustable stops are mounted on either side of the head. The chisel headstock is controlled by a machine-cut rack and gear wheel and is operated by a hand lever. By means of a depth stop the machine can easily be adjusted for various depths of blind mortices. Longitudinal traverse of the machine is by a rack and pinion wheel, and the cross traverse is operated by a hand wheel and screw. The machine takes chisels and bits from ¼in. to ¾in. square and ordinary boring bits up to 1½in. diameter. Mortices up to 6in. deep can be cut.

C. A. Parsons and Co., Ltd.

Representing the manufacture of turbo-alternators, turbine blading, electric welding plant, boiler auxiliary apparatus, searchlight reflectors, and marine engineering parts a number of exhibits would have been on the stand of C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-on-Tyne.

In Fig. 53 we illustrate a model one-sixteenth full size to have been shown of one of two 50,000-kW, 3000 r.p.m., turbo-alternators complete with surface condensing plant, constructed for the Bunnerong power station, Sydney, Australia. The turbine operates with steam at a pressure of 600 lb. per square inch at the stop valve and a temperature of 825 deg. Fah., exhausting at a vacuum of 28·5in. mercury. Each machine is arranged in the form of three cylinders coupled to a single alternator and exciter. Three-phase current is generated at 11,000 volts, 50 cycles per second. Ventilation of the alternator is effected by a closed circuit system, which is arranged to include the main brush gear and exciter. An illuminated sectional drawing mounted in front of the model would have shown the construction of the machine.

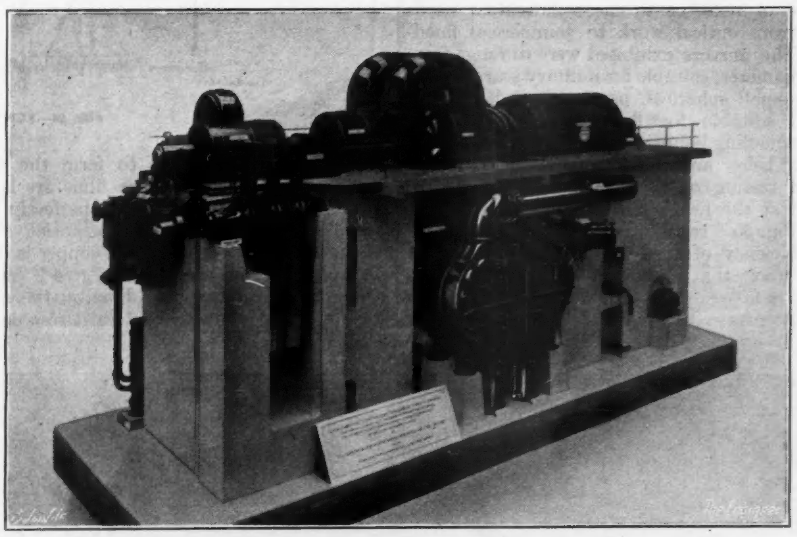

FIG. 53—MODEL OF BUNNERONG TURBO-ALTERNATOR—PARSONS

A similar model was to have shown one of the two 50,000-kW, 1500 r.p.m. turbo-alternators recently installed in the Dalmarnock power station of the Glasgow Corporation. We have referred on several occasions to this installation in these columns. The turbine has two cylinders and operates with steam at the same conditions at the stop valve as the Bunnerong units. The exhaust vacuum is 29in. and the generator supplies three-phase current at 20,000 volts, the conductors being of the high-voltage concentric type. The model is complete with surface condensing plant, feed water heaters, and all the necessary pipes and valves.

Another exhibit was to have the form of a board on which are mounted one-twenty-fourth scale model silhouettes of 3000 r.p.m. turbo-alternators, showing their development in size in the past fifty years. The increase in the size of turbo-alternators has been accompanied by higher steam pressures and temperatures, and higher efficiencies, resulting in a reduction of the weight per kilowatt output and an increase in the output per square foot of floor space occupied. The table below gives a comparison of the 350-kW turbo-alternator constructed in 1894 with the 50,000-kW turbo-alternator constructed in 1939:

	1894.	1939.
Output in kilowatts ...	350	50,000
Steam pressure, pounds per square inch gauge	150	600
Steam temperature, deg. Fah.	366	825
Length of turbo-alternator	24ft. 8in.	73ft.
Floor space occupied, square feet	98·6	950
Kilowatts per square foot of floor space	3·55	52·6
Weight of turbo-alternator, tons	20	300
Weight in pounds per kilowatt	128·0	13·5

The exhibits relating to the manufacture of turbine machinery were to include examples of built-up sectors of reaction blading and finished impulse blading. There would also have been a bladed model of a sector of a low-pressure turbine shaft for a tip speed of 1200ft. per second. The blades are of the integral type in which the combined blade and spacing piece are produced by rolling from a single billet. To reduce the centrifugal stress in the blades in the last row they are rolled hollow, and to prevent erosion hardened shields are fitted to each blade in the last two rows. Samples of the blades in each row would have been available for inspection.

A new type of boiler water gauge projector would have been on view. The arrangement of the device is shown in the accompanying engraving, Fig. 54; it consists of two units, the upper gear and a floor pedestal. The upper gear consists of an arrangement for projecting a beam of light through the boiler water gauge, which is split into red and white portions and reflected through a right angle vertically downwards to the floor pedestal and then projected on a screen. The pedestal is placed as nearly as possible beneath the boiler water gauge. On looking at the image in the screen, the water level is indicated by the line of demarcation between red and white portions of the beam of light. Several important advantages are claimed, including that of being able to see a brilliant correct image of the gauge on the firing floor at a distance and through a considerable angle of vision. No pipe connections or additional valves are required between the gauge and the screen, and once the apparatus is properly adjusted there is no need for further adjustment. Moreover, since the image is shown in two colours, there is no possibility of a misreading or of confusing an empty with a full glass.

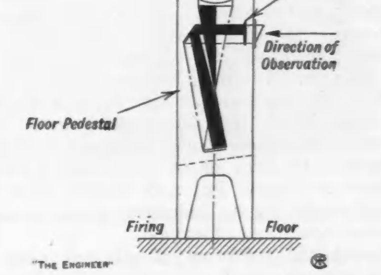

FIG. 54—WATER GAUGE—PARSONS

Other exhibits on the stand were to include a

6-kVA welding shell-type transformer designed for a voltage range of 440 to 60 volts. Three tail shaft liners of different diameters, cast and machined at the firm's Walkergate works, would have represented the activities of that department.

The manufacture of searchlight reflectors, both of silvered glass and rhodium-plated metal, was to have been shown by examples varying from 10in. to 36in. diameter. The firm makes rhodium-plated metal reflectors by the Bart process, a method entirely of electro-deposition, producing a highly finished first reflecting surface. The reflecting surface is of rhodium, a precious metal, belonging to the platinum group. It has a high reflectivity, is hard, of a brilliant " white " colour, and is immune from tarnishing effects. Being a first surface reflector the effects of refraction, of transmission, and of reflections from secondary surfaces are absent. The manufacturing process, we are informed, makes it possible to reproduce any type of reflector to meet individual needs ranging from optical work to commercial floodlights. The mirrors exhibited were to range from 36in. in diameter, suitable for military searchlights, down to small spherical, parabolic, and elliptical reflectors suitable for floodlights, cinema projectors, signalling lamps, and so forth.

Set out below are some notes on the manufacture and testing of silvered glass reflectors, as produced at the firm's Heaton works. We illustrate in Fig. 55 a range of such reflectors.

The efficiency of a searchlight depends almost entirely upon the quality of the reflector with which it is fitted. The function of this reflector is to concentrate the rays of light and project them as a sharply defined beam without sensible diffusion or loss. The form of the reflector must be accurately parabolic at all parts or there will be dispersion of the light, and the coefficient of reflection of the silvered surface must be as near as possible to unity or some of the light will be uselessly absorbed. On the degree to which these two requirements are fulfilled depends the intensity of the beam and consequently the range of effective illumination by the searchlight. It is further essential that the reflector shall not be liable to distortion by heat or to injury from moisture, deleterious fumes, &c., and that it shall retain its efficiency for an indefinite period under the severest conditions of service.

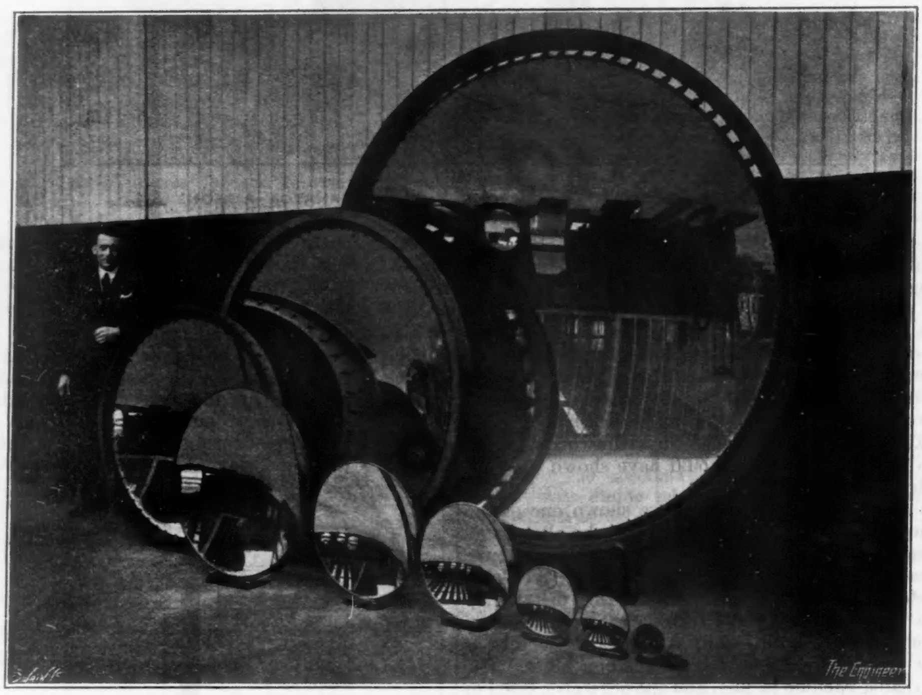

FIG. 55—GLASS REFLECTORS—PARSONS

Searchlight reflectors of silvered glass have been manufactured uninterruptedly by C. A. Parsons and Co., Ltd., for nearly fifty years, during which time a very large number have been supplied for naval, military, and commercial purposes in all parts of the world. The firm thus possesses much experience of the production and behaviour of such reflectors, and wide facilities for their manufacture and testing. Accurate parabolic reflectors of more than 84in. diameter have been produced at Heaton Works, and we are informed that considerably larger ones could be made if there were any demand for them.

The glass used for the manufacture of reflectors is carefully selected to ensure that it is free from colour, flaws, bubbles, or any other defects. After being worked to the required parabolic form, it is thoroughly annealed to remove all traces of internal stress, and is then carefully ground and afterwards highly polished on both faces by machinery devised for the purpose. Pure silver is then chemically deposited on the convex side of the glass to form the reflecting surface. Several consecutive films are laid on in order that the coating shall be perfectly uniform, free from holes and of substantial thickness. After this operation a layer of copper is deposited electrolytically on the silver to give it mechanical strength and protection. Finally, the copper is covered by a durable and heat-resisting paint, the composition of which has been determined by long and careful experiments, or, alternatively, it is protected by a lead backing or by the firm's lead and wire backing, according to requirements.

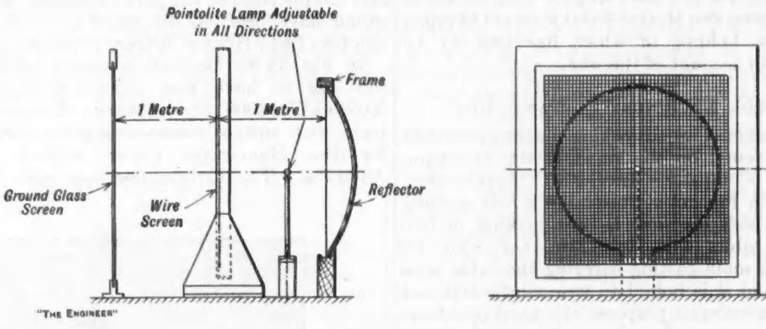

FIG. 56—TCHIKOLEFF TEST OF REFLECTORS

Since the silver reflecting surface is on the back of the glass, it remains untarnished, while the face of the reflector can be cleaned and polished as often as may be necessary in the same way as an ordinary mirror.

Lead and wire backing was introduced by the firm in 1914, during the war, to minimise the risk of a searchlight being put of action by an accident to the reflector. The backing consists of a sheet of lead, shaped to make perfect contact with the back of the reflector, the edges being turned over the rim of the latter. It is held in position by a netting of phosphor-bronze wire stretched tightly over it. The netting is secured by a channel-shaped circumferential band of copper which forms the rim of the reflector. The backing holds the reflector together and maintains it in a serviceable condition even after an injury which would shatter an ordinary reflector. A reflector with lead and wire backing may even be struck by a rifle bullet without its usefulness being appreciably impaired.

A further advantage of the lead and wire backing is the protection it affords against the effect of fumes from oil fuel or the presence of corrosive gases. The coating of lead entirely prevents the access of such fumes to the silver of the reflecting surface, and thus eliminates this source of danger to the durability of the reflector.

A theoretically perfect searchlight would project a parallel beam of light which would illuminate a distant object as brightly as if the source of light were of the same diameter as the reflector. To obtain such a result the reflector would have to be accurately parabolic at every point, and the source of light of infinitely small dimensions. The latter condition is, of course, unattainable in practice, and with the electric arc or incandescent lamp customarily employed, some divergence of the beam is inavoidable.

Since the actual reflecting surface of a searchlight reflector is at the back of the glass it is not accessible for ordinary mechanical methods of measurement, while, even if it were, the accuracy required is so great that such measurements would be powerless to detect the minute differences that distinguish an unsatisfactory reflector from a good one. Optical methods of testing are therefore employed, the accuracy of the reflector as a whole, and of every part of it, being determined by its actual performance. The principal tests are briefly referred to below.

The focal length is the distance from the reflecting surface at which parallel rays of light, entering the mirror axially, would be brought to a focus. This distance is of importance because it connotes the exact position which the positive crater of the arc lamp must occupy if the beam of light is to be as nearly parallel as possible. The focal length is determined by using the reflector to focus the light from a small and distant source on to a small screen and measuring the distance of the screen from the back of the reflector. A pointolite lamp, mounted on the optical axis of the reflector at a distance of 65 m., is employed as the source of light. Although the lamp is a long distance away, the rays from it nevertheless diverge appreciably from true parallelism. So, to avoid error from this cause a large plano-convex lens is interposed in their path to obtain the necessary parallel light for the testing of reflectors up to 1300 mm. diameter. For reflectors above this size the true focal length is obtained by applying a mathematical correction to the length as measured with the divergent rays proceeding directly from the lamp as shown in Fig. 57.

All reflectors are subjected to the Tchikoleff test, which not only shows the performance of the mirror as a whole, but affords also a useful means of detecting almost invisible defects in the glass. The reflector to be tested is mounted with its axis horizontal and a pointolite lamp is placed at its focus. About 1 m. from the front of the reflector is placed a frame carrying a network of tightly stretched vertical and horizontal wires spaced 50 mm. apart, and dividing the surface into a series of small squares. Parallel to this network and 1 m. in front of it is a ground glass screen on which is projected a clear shadow of the network as shown in Fig. 56. If the reflector is truly accurate the rays of light leaving it will be parallel and there will be no distortion of the lines of the network which are seen on the screen. If, on the other hand, the reflector is not of perfect parabolic form, the image of the network will be distorted and the lines will not appear straight. Should the deviation from straightness exceed a specified amount, the reflector is rejected.

Another test applied to all reflectors is the " zone test," which serves as a check upon the parabolic form and particularly on the equality of the focal lengths of various portions of the reflector. The test is a very important one, as will be seen from the fact that as much as 20 per cent. of the light from an ordinary 90 cm. diameter searchlight may be lost if the outer 5 cm. of the reflector are different in focus from the remainder.

In carrying out the zone test the reflector is set up as for the focal length test. The arrangement is shown diagrammatically in Fig. 57. Rays of light from a distant lamp, rendered parallel by a plano-convex lens, fall on the reflector, which, together with the ground glass screen, is so adjusted that the optical axis passes through the centre of both reflector and screen. This adjustment can be readily effected by noting the characteristics of the spot of light on the screen. During the zone test, the whole of the reflector is not illuminated at the same time, successive portions being obscured in turn, so that only an annular portion receives the light at any one time. The light is shut off from the parts of the reflector not under test by a plate perforated to admit a ring of light of the required diameter. The screen is then traversed by a micrometer screw until the light from the illuminated zone of the reflector is focused upon it, and the focal length of this zone is noted on a graduated scale. The same procedure is repeated with another plate until the whole of the surface of the reflector has been tested on a series of rings. In an absolutely perfect reflector all the measured focal lengths would be equal and if, in practice, the discrepancies exceed a certain specified limit, the reflector is rejected.

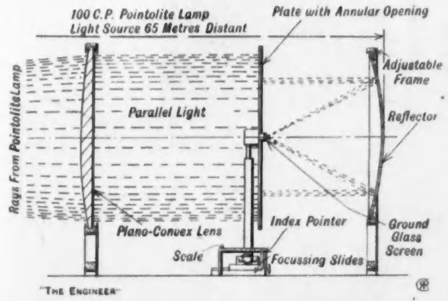

FIG. 57—DETERMINATION OF FOCAL LENGTH

With an elliptic reflector the rays reflected from a source of light at one focus first converge to a point at the conjugate and subsequently diverge indefinitely at the same angle. It follows, therefore, that if a reflector is so shaped that its vertical section is a parabola and its horizontal section an ellipse, the projected light will converge to a vertical line at the secondary focus of the ellipse, and then spread out sideways in a flat beam. Parabolic-elliptic reflectors of this nature are of great importance for certain purposes. When employed in searchlights they enable the beams to pass through narrow loopholes, as, for instance, a blockhouse, so that the apparatus is largely protected from damage by gunfire. The flattened nature of the beam, moreover, allows a large area to be illuminated at the same time without waste of light in a vertical direction. This characteristic is valuable for the lighting of aerodromes, harbours, &c., where large spaces have to be well illuminated. Searchlights fitted with parabolic elliptic reflectors are also useful in facilitating the navigation of narrow waters, canals, &c.

Parabolic elliptic reflectors are manufactured in a large variety of sizes and focal lengths to project flat beams diverging from 8 deg. to as much as 45 deg.

By making a reflector in halves which are hinged together, it may be used to project either a single beam of light or two beams making any desired angle with each other. Reflectors of this kind were introduced by C. A. Parsons and Co., Ltd., many years ago, and have found a wide field of usefulness. With a split parabolic-elliptic reflector a beam can be obtained of any width from half the divergence to the full divergence of the reflector, or two beams with a dark space between them may be obtained. This arrangement renders them very suitable for vessels navigating the Suez Canal. When passing along the canal a single beam with a divergence of about 12 deg. is normally used, but on the approach of another ship the beam is divided so as to illuminate the buoys on either side of the fairway while leaving a dark space directly ahead. The pilot of the oncoming ship is therefore not dazzled by the light of the projector and both vessels can pass in safety.

In addition to the types of reflectors described above, Parsons manufacture reflectors of spherical, ellipsoidal, and hyperbolic form to meet particular requirements. Such reflectors are made with the same high degree of accuracy as those of the more usual parabolic form, and they are provided with the same types of protection against mechanical injury, corrosive fumes, and so forth.

C. H. JOYCE, LTD.

The "Lienhard" engraving machine, Fig. 47, p. 304, by C. H. Joyce, Ltd., 115, Southwark Street, London, S.E.1, has been particularly designed for high-speed precision work. It has a table 20in. long by 10in. wide, which has a longitudinal movement of 12in. and a transverse movement of 8in. The table moves up and down on accurately hand-scraped slides, and has a vertical movement of 13in. All movements are effected by conveniently placed graduated hand wheels. The pantograph has strong links, all of which move on ball bearings and incorporate provision for taking up any wear. A chart supplied for setting the graduations on the pantograph permits the machine to be set for standard reductions from 1 : 1 down to 1 : 50, and by means of a formula fractional reductions not listed may be obtained. The copy holder is 22in. long by 13½in. wide, and contains seven grooves for standard copies 1¼in. high. The cutter spindle is of hardened and ground steel and runs in ball bearings. It is designed for four normal working speeds from 4200 up to 11,000 r.p.m., but can be run at 40,000 r.p.m. In one setting the cutter covers a space of 11in. by 8in., its maximum distance from the table being 13in. An extra cutter sleeve is supplied for standard English cutters. Tension on the driving belt is maintained by mounting the motor on a hinged base so that its weight acts in a similar manner to a jockey pulley.

For engraving curved and uneven surfaces a forming attachment can be incorporated on the cutter head. With this attachment a model of the working surface is rigidly fixed above the workpiece, and over it a tracer, coupled to the cutter, traverses. As the tracer follows the contour of the model, its movements are reproduced in the cutter on the workpiece. The area of work covered in this way is restricted and if large surfaces have to be covered it is necessary to divide them up into sections. When working over slightly curved or irregular surfaces an attachment known as a presser foot is fixed to the cutter head. The foot rests on the work and the cutter protrudes through it, and in this manner up and down movements of the foot are reproduced on the cutter spindle to maintain a constant depth of cut.

The machine is adapted for conversion to a small vertical milling machine by replacing the pantograph head with a milling attachment. This attachment is mounted on a beam which is bolted to the machine over-arm. On one end of the beam is a bracket carrying a small electric motor which drives, through a belt, the spindle of the milling head at the other end of the beam. The milling head moves up and down vertical slideways at the forward end of the beam, and has a movement of 2⅜in. The spindle, which has a chuck capacity of 13/16in., has three speeds from 1400 to 6000 r.p.m.

THE ENGLISH ELECTRIC COMPANY. LTD.

A representative range of A.C. welding equipment would have been exhibited by the English Electric Company, of Stafford, and practical demonstrations of its use would have been given. Among these equipments is the multi-operator unit (Fig. 58), comprising an oil-immersed transformer and three sizes of welding regulators. Each of the welding regulators connected to this transformer is capable of dealing with current up to 300 amperes. The transformer is connected delta inter-star and gives the maximum possible equal distribution of current on the primary side under welding conditions.

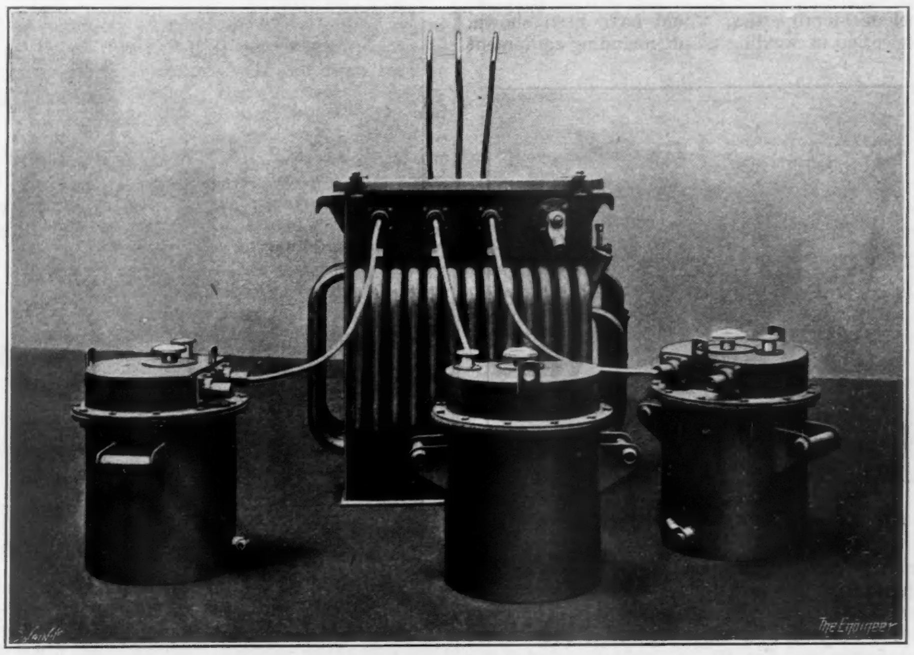

FIG. 58—MULTIOPERATOR WELDING UNIT—E.E.C.

Insulated and mechanically interlocked plug and socket connectors are provided for connecting the transformer to the regulators, which are oil immersed. An externally operated switch on the cover of each regulator selects the current values to suit the particular electrode in use. Either twenty-four or thirty-six steps are provided, according to the size of the regulator, and are suitably graduated over the complete range. Three sizes of regulators would have been shown—a 400-ampere equipment having a current range from 95 to 400 amperes in twenty-four steps; a 300-ampere regulator with a range from 35 to 315 amperes in thirty-six steps; and a 200-ampere equipment with a range from 17 to 210 amperes. The latter is of the universal type and is suitable for electrodes from 20-gauge to 4-gauge. A 200-ampere regulator recently introduced has a current range of 15 to 120 amperes in eighteen steps and is of particular value to sheet metal workers and in garages, &c.

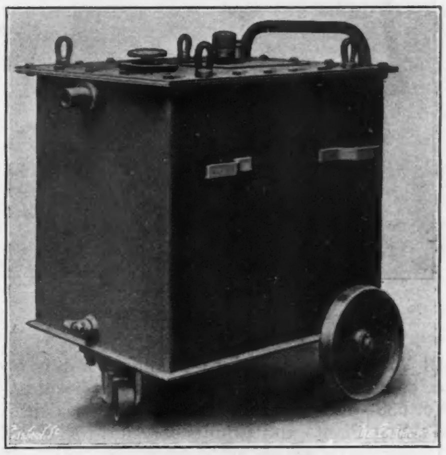

FIG. 59—PORTABLE WELDING EQUIPMENT—E.E.C.

Among other products are oil-immersed portable equipments, as shown in Fig. A59, comprising a welding transformer and regulator in one tank. Insulated and mechanically interlocked plug and socket connections are provided for connecting the transformer to a 415-volt power supply, and similar connections for connecting the regulator to the electrode holder. A switch on the tank cover is used for selecting the current values. Four sizes of these equipments would have been exhibited.

MUREX WELDING PROCESSES, LTD.

On the stand of Murex Welding Processes, Ltd., Waltham Cross, Herts, there would have been a display of electrodes suitable for welding ferrous and non-ferrous metals. Sample welds produced with various types of electrodes, with data of the mechanical properties, would have been shown. A selection of welding plant, including equipment for A.C. and D.C. welding, would also have been exhibited. This included a two-operator transformer set, Fig. 60, with a capacity to each operator of 350 amperes; a single-operator, 250-ampere transformer set, Fig. 61; a single-operator motor generator set, giving 400 amperes at 30 volts, fitted with three pneumatic-tyred wheels; a mobile petrol engine driven arc welding plant, Fig. 62, for one operator mounted on a two-wheel pneumatic-tyred trailer for high-speed towing, and a portable oil engine driven set, with a capacity of 400 amperes at 30 volts, and fitted with four cast iron wheels.

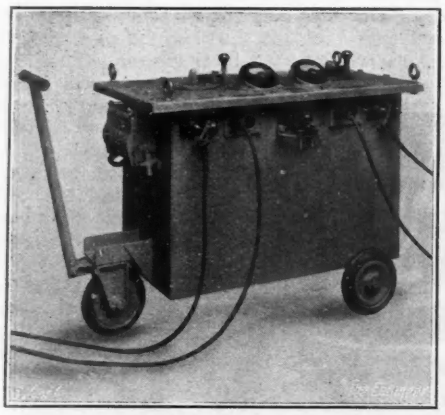
FIG. 60—WELDING TRANSFORMER—MUREX

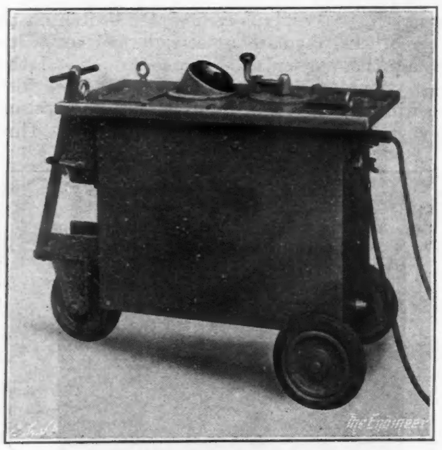
FIG. 61—WELDING TRANSFORMER—MUREX

All "Murex" electric arc welding plant is built to comply with British Standards Specification No. 638—1935 (B.S.S. for Rating of Electric Arc Welding Plants and Equipment, and for Welding Accessories), which safeguards the purchaser's interests by ensuring that the rating is such as to prevent excessive temperature rise.

Accessories on the stand would have included "Lamurex" and "long life" cover glasses for welders' screens and masks. Products representing various applications of electric welding would also have been shown. Of special interest to users of gas welding is a process known as the automatic "Gasflux." "Gasflux" is the name given to the modern scientific method of applying flux to brazed or welded seams, and consists of a device which can be fitted into the gas service pipe of the heating torch and so supply the flux in gas form to the flame. As the volume of the fluxing gas fed to the flame can be controlled within very fine limits, the process is very economical and clean as compared with the old method of applying flux in powdered form and the necessity of applying excessive quantities of powder to ensure efficient fluxing is avoided. Moreover, the advantage of being able to apply a regularly controlled stream of flux exactly where it is required, and the fact that there are no solid particles which might become trapped in the molten metal, result the maker's claim in greater efficiency of the joint. Considerable time is also said to be saved in fettling the finished job, as the "Gasflux" leaves a joint which, at the most, only requires a light wire brushing before being put into use. As the flux is fed under pressure of the fuel gas on to the surface to be jointed, it ensures a more intimate contact with the metal than with other processes, and its superior fluxing qualities results in greater uniformity and strength of joint. Powdered fluxes applied by sprinkling or in paste form which dries out on the application of heat, are, it is alleged, extremely wasteful, as a large proportion of the flux is blown away by the gas pressure of the flame.

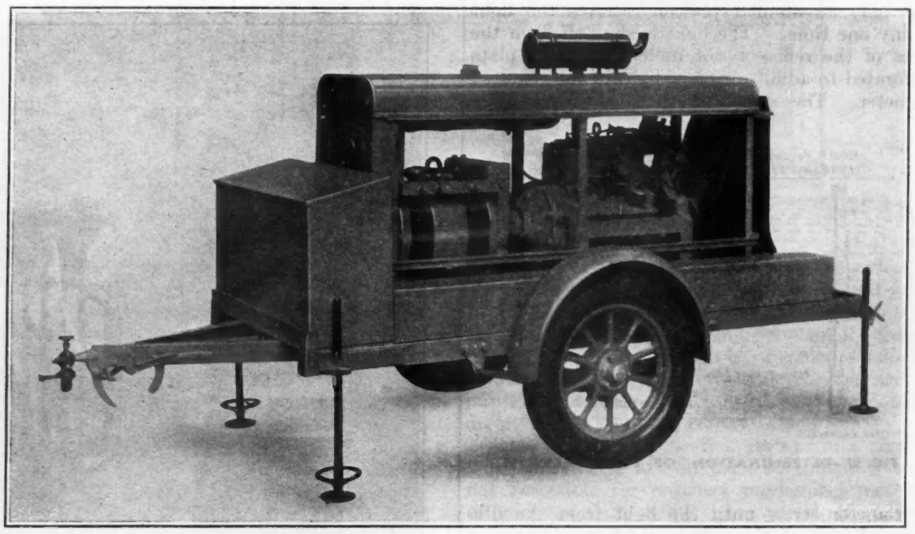
FIG. 62—PORTABLE ENGINE DRIVEN WELDER—MUREX

NEWCON FILTERS, LTD.

Two types of filters made by Newcon Filters, Ltd., 149, Edinburgh Avenue, Trading Estate, Slough, were to have been shown on its stand. One is designed for handling high-pressure liquids at capacities ranging from 500 to 50,000 gallons per hour, and the other for lower pressure liquids at capacities from 120 to 1400 gallons per hour. These filters were described in some detail in our issue of May 19th, 1939.

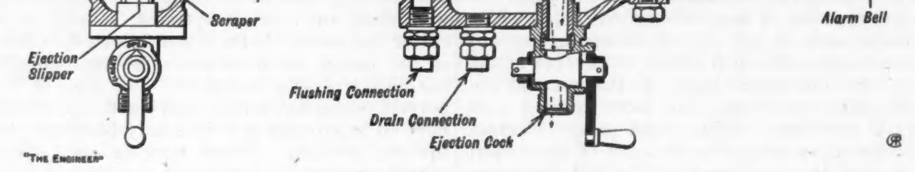

FIG. 63—ROTARY FILTER—NEWCON

The arrangement of the larger filter, which is of the rotary type, is shown in Fig. 63. In this the liquid passes into a chamber formed between the filter wall and two perforated metal cylinders, between which is held a fine metal gauze. The liquid is forced through the perforations and gauze into the inner chamber, whence it passes to the outlet, the suspended impurities being retained on the gauze. At the end opposite the outlet the filtering cylinder is sealed by a head incorporating a cylinder, in which a piston slides. The front of the piston is open to the filtered liquid, and its rear to the unfiltered liquid. A small bell crank lever connected to the piston spindle operates a pressure alarm bell. A hand wheel on the end of the filter box serves to turn the whole of the filtering assembly within the body.

In operation, when the filtering medium is passing a liquid freely, the piston is kept at the back of the cylinder, as shown in the drawing, by a spring. As the gauze becomes clogged with impurities, pressure builds up in the outer chamber and forces the piston forwards eventually to ring an alarm bell. The ejection cock is then closed, and, after the locking pin has been released, the hand wheel is given one complete revolution.

By this the whole of the filtering area is passed over an elongated orifice along an ejection slipper set in the base of the filter body. The orifice in the slipper opens into the ejection cock, and, as the filtering cylinder passes over it, the pressure of the filtered liquid within forces the foreign matter out of the holes into the orifice. Any solid matter which has built up on the outer perforated metal cylinder is cleared by a spring-loaded scraper on the side of the slipper and falls to the bottom of the filter body to be discharged through a drain. On the balance of pressure being restored by cleaning, the piston is returned by the spring on its spindle to its normal position at the top of the cylinder.

When working with a very viscous liquid, or, after being left unused for some time, the filtering medium may become clogged and a flushing-out connection is provided to which a steam line may be coupled for completely cleaning the interior.

The smaller filter is shown in Fig. 64, and, as may be seen, comprises two annular chambers between the body and a central cylinder in which a hand-operated piston works. Liquid to be cleaned passes into the outer chamber between the body and a filter cloth suspended on a perforated cylinder. It passes through the filtering medium into the second chamber, which is open at the top to the outlet and also to the top of the piston in the inner cylinder. As long as the liquid passes freely through the filter cloth the balance of pressure is maintained to keep the piston at the bottom of its cylinder. When the filter becomes clogged with foreign matter, the pressure in the outer chamber builds up and that on the top of the piston drops in proportion to the degree of obstruction. This change in pressures opens up a main valve in the bottom of the cylinder to allow unfiltered liquid to pass into a cavity under the piston. Thereupon the piston begins to rise, the pressure below being greater than that above. This rising movement is shown by the lifting of the handle on the end of the piston spindle. To clear the filter the handle is given a quick upward movement. This upward movement of the piston sets up a back pressure in the upper part of the cylinder, and the clean liquid is forced back from the intermediate chamber through the filter cloth. The pressure of the returning liquid forces back any deposited foreign matter into the outer chamber. The upward movement of the piston also creates a vacuum in the lower part of the cylinder and causes the ejected foreign matter in the outside chamber to be sucked back past the main valve into the space under the piston. A downward movement of the handle forces the piston down, closes the main valve, and opens an ejector valve below, through which the foreign matter is discharged. The handle is left down until it begins to rise again, indicating the necessity for another cleaning stroke.

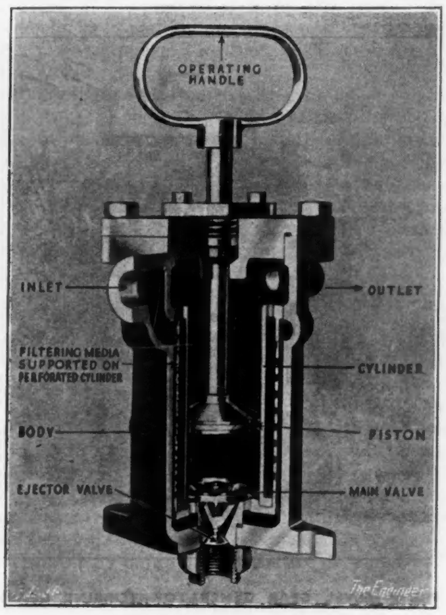

FIG. 64—SMALL FILTER—NEWCON

E. LEITZ (LONDON), LTD.

On the stand of E. Leitz (London), Ltd., of 20, Mortimer Street, W., optical apparatus for research and laboratory work would have been shown, including instruments for surface testing, the examination of structure, and for the testing of dies, stampings, forgings, and screw threads for accuracy of form. In the instruments for surface testing examination is carried out by means of low-power microscopes and magnifiers of the monocular and binocular types. By reason of their wide field and stereoscopic vision, binocular magnifiers afford a convenient method of rapidly examining large surfaces for possible flaws. For higher magnifications a special illuminator, such as the Leitz "Ultropak" magnifier, is essential. With its aid the highest microscopical magnifications may be employed. A new surface tester for comparing the finish of all kinds of surfaces incorporates the stereo-binocular body of the Greenough microscope and affords binocular vision and eliminates strain and fatigue.

The structure of metals and alloys is investigated by polishing and etching their surface so as to bring the various constituents into sharp relief. These extremely small constituents are then examined under a metallurgical microscope, when they may be photographed.

The firm's dilatometer is used for recording automatically the curve of the thermal behaviour of small samples of metals and alloys. Their behaviour under any given condition may be predicted with great accuracy, thus reducing the risk of failure. The photomicrographic equipments and the "Ultropak" illuminator mentioned are also widely used in connection with the countries' coal resources. A precise classification in order that the different kinds may be used in a manner best suited is essential, and the slit microphotometer plays an important part in determining the age of the coal, a factor which has a considerable bearing on its hardness.

The Leitz Tyndallometer is used for testing the efficiency of gas masks and respirators, and is of value in research work on the causes of silicosis or miners' phthisis.

THORN AND HODDLE, LTD.

The products of this firm, whose offices are at 151, Victoria Street, S.W.1, consist of various types of acetylene generators, both water to carbide and carbide to water. Portable and stationary models are made, also blow-pipes for high and low pressure, the latter having a patented non-backflash injector. The firm's latest regulator reduces the cylinder pressure in two stages and ensures the steady pressure essential for effective welding. Another more or less new product is a gas saver which cuts off the supply of gas when the blow-pipe is out of use, thus combining safety with economy. Welding accessories include regulators, back-pressure valves, goggles, tubing rods, fluxes, &c. On the lighting side there are portable acetylene flares for temporary lighting.

THE FOSTER INSTRUMENT COMPANY, LTD.

The Foster Instrument Company, Ltd., of Letchworth, Herts, would have shown a comprehensive range of electrical temperature measuring instruments for industrial and laboratory use, including thermocouple, optical and fixed focus radiation pyrometers, and electrical distance thermometers. Indicating and recording instruments are designed for wall and panel mounting, and include multipoint recording, producing up to six records in different colours on a wide chart. The continuous charts are printed in two colours. These recorders are also made to control automatically as well as to record temperatures in connection with oil, gas, and electrically heated apparatus. "Lamp bridge unit" optical pyrometers, suitable for measuring temperatures above 700 deg. Cent., incorporate a Wheatstone bridge and lamp which are interchangeable without recalibration of the indicator movement. An improved optical pyrometer is specially well balanced when readings are being taken, whilst the instrument is held in the hand. It has a long scale and an efficient vernier rheostat.

The electrical distance thermometers are suitable for refrigeration chambers, chemical works, &c., and are available as multi-point instruments comprising a single indicator used in conjunction with a switchboard. Multi-point recording up to six stations is possible on one instrument.

The Foster Introscope intended to be shown is virtually a low-power illuminated microscope, supplemented by an optical system which transmits the image to the user's eye outside a tube or other deep enclosure. It can be inserted for considerable depths into restricted apertures, and with the aid of the self-contained lamp the user sees the interior surfaces magnified and thrown into high relief, as if he were actually inside the tube.

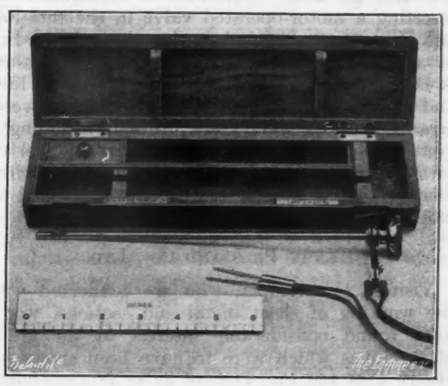

FIG. 65—INTROSCOPE—FOSTER

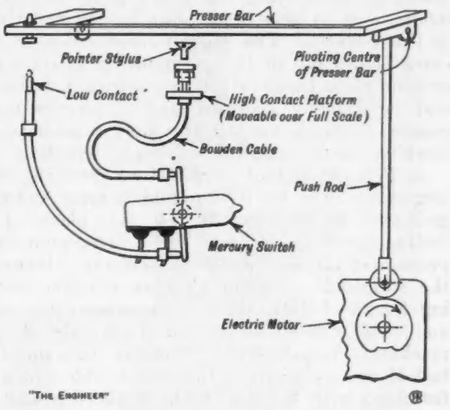

FIG 66—INDICATING CONTROLLER—FOSTER

The Foster Flexipush indicating controller, shown in Figs. 66 and 67, gives full automatic control of temperature without the use of exposed contacts, delicate electro-magnetic relays or complicated gear usually associated with this class of apparatus. The final control, which is in the instrument itself, is in the form of a mercury tube switch, which is tilted to the requisite angle and direction by a motor-operated depressor and two selector tables adjustable over the full-scale range. One of these tables is depressed periodically, according to the position of the indicator, the tables being linked to the mercury switch by Bowden transmissions. The pivots and jewels of the moving coil system

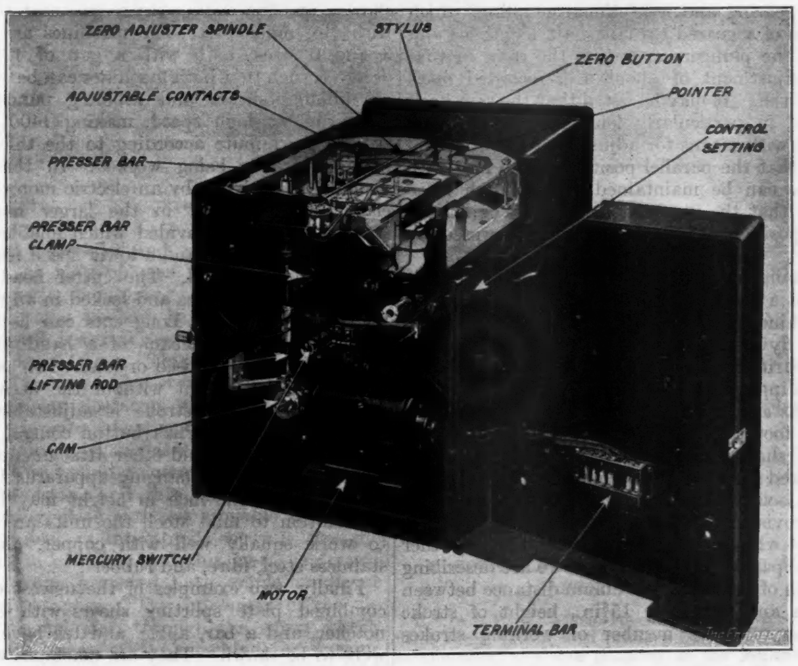

FIG. 67—FLEXIPUSH CONTROLLER—FOSTER

incorporate the firm's patented Resilia mounting system, and are relieved of any damaging stresses which might otherwise result from the periodical control impulses. Reliable control with fine discrimination and maintained accuracy are secured. Oil and gas-fired apparatus is controlled by inserting a motor-operated valve in the fuel line and the quantity of fuel flowing through the line is varied by the controller. Where air under pressure is used a valve is often incorporated in the air line, and is also connected to the controller. Several arrangements of valves are utilised, including a system which will maintain a constant fuel/air ratio for application to a forced draught gas-fired furnace. Other heating systems are controlled by motor-operated dampers, fans, &c.

HENRY PELS AND CO., LTD.

Visitors to Olympia, who are connected with the working of sheet metal and sections, would have found considerable interest in the group of machines which were to have been shown by Henry Pels and Co., Ltd., of 32 to 38, Osnaburgh Street, London, N.W.1. All the machines, including a large folding press, a guillotine shearing machine with a drawing cut and a variable cutting rake, high speed nibbling shears and punches, and two combined plate splitting shears with a punch, bar angle, and tee bevel cropper, were arranged to have been belted up so that all operations could have been demonstrated. These machines, embodying the firm's latest improvements, were to have been shown for the first time in this country. The general construction in all cases makes use of the permanently guaranteed armour plate frame which is electrically welded, and is specially designed and dimensioned to ensure extraordinary rigidity and resistance to working stresses, and absence.of any deflection.

In Figs. 50 and 51 on p. 304 we show the two largest machines, the 100-ton folding press, and the guillotine shears for 12ft. by ⅛in. plate. The folding press is designed for a maximum end pressure of 120 tons, and it has a distance between the standards of 102in. with an effective working length of 13ft. 4in., which includes the ram and table extensions of 20in. each side of the machine. As will be seen from our engraving the bed of the press carries the actual table which is furnished with tee slots both on the top and at the sides for fixing the lower tool. Provision is also made for fitting these presses with either shearing or multiple punching tools should these be desired. The ample height of the bed does away with any possibility of deflection, and the work turned out is, it is claimed, absolutely straight and uniform. Fine adjustment of the ram can be made by means of the handwheel shown. The handwheel actuates a 4 B.H.P. reversible motor through gearing and a frictional coupling, which by means of a geared cardan shaft lengthens and shortens the plungers operating the ram, so that a fine adjustment of about 4in. recorded on a scale is given. It may be noted that the ram itself is carried in particularly long guides which are provided with means for adjustment in two directions so that the parallel position of the ram with the table can be maintained. The clutch is so designed that the ram can be stopped or started in any position or can be raised or lowered by degrees.

The main drive is from a 10 B.H.P. motor, by means of a vee belt to the flywheel. The gears are machine cut and are provided with guards, and the flywheel and flywheel shafts both run in roller bearings. The clutch is of a type which allows slipping to take place under overload conditions and it can be operated either by hand or by a foot treadle. A hand brake acts on the flywheel shaft, and is used to stop the ram in any desired position, after disengagement. Should the ram seize owing to faulty adjustment of the tools, provision is made to release it by means of a ratchet wheel mounted on the shaft. The other principal particulars of the press we are describing are width of bed 7⅞in., maximum distance between the ram and the table 15¾in., height of stroke 3⅛in., approximate number of working strokes 30 per minute.

A specially interesting feature of the press is the safety device consisting of a beam of light along the length of the press which, when optically interrupted by the hand of the operator or any other means, actuates a photo-electric cell, which through relays stops the press. This type of safety device has been adopted with success on the Continent, and it is claimed that unlike mechanical safeguards which under the Factory Act must be provided, it does not tend to hinder the operator and reduce the output of the machine.

The press we have described is used for a variety of work, such as the manufacture of steel structures, doors, door frames and window work, containers, boxes, conveyors, tranformers, and switchboards, and for aircraft construction.

The guillotine shears with a drawing cut and a variable cutting rake shown in Fig. 51 represents the latest development of this type of machine which has now entirely superseded the earlier pattern with the vertical cut. The present type has found a wide use in the aircraft industry on account of the ease with which it is possible to cut very narrow strips without either twist or curl. The machine is the No. 3 size, which has a capacity for shearing mild steel sheets from 1/16in. to ⅛in. thickness with cutting rakes of one and three degrees, and trimming strips not exceeding 2in. in width, up to ⅛in. in thickness, with a cutting rake of three degrees. The effective length of the cutting blades is 145in., the shear blades having a length of 150in., and the distance between the standards being 147in. The gap is 24in. and the number of strokes 32 per minute. A motor of about 7 B.H.P. is required to drive the machine. In the design of these shears, safety has been carefully studied and we may draw attention to the use of wire mesh safety guards on the downholder beam, which prevent the operator from placing his hands between the blades. The guards are clearly shown in our engraving.

Another exhibit which we illustrate in Fig. 68 herewith, is the high-speed nibbling shears and punch, two of which machines were to have been shown, one for dealing with ⅛in. and the other with ¼in. mild steel. The machines are number 3 and 6 sizes, both with a gap of 42in. The design is such that both machines can be employed as nibbling shears and nibbling punches, and they run at high speed, making 1400 to 1100 strokes per minute according to the thickness of metal which is being worked. In the smaller machine the drive is by an electric motor with an elastic coupling, but in the larger machine a stepped pulley is provided which enables a high speed for light work and a lower speed for heavier work to be obtained. The cutter head can be turned full 360 degrees and locked in any position by the locking pin. Long cuts can be made in all directions. By means of a hand wheel the shear blade can be raised or lowered so as to start shearing at any point without the necessity for pre-punching. The stroke is adjustable and is shown on a scale. Push button control is fitted on these machines, and other attachments include circle cutters and a flanging apparatus by which flanges up to one inch in height may be made. In addition to mild steel, the units are designed to work equally well with copper, aluminium, stainless steel, fibre, and rubber !

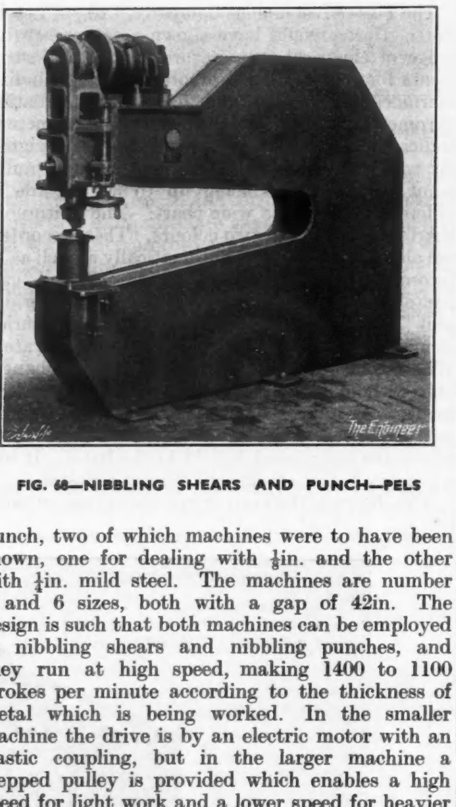

FIG. 68—NIBBLING SHEARS AND PUNCH—PELS

Finally, two examples of the newest design of combined plate splitting shears with a punch, notcher, and a bar, angle, and tee bevel cropper were to be shown. They are machines which are useful in all constructional steel work. The robust nature of the built-up and welded armour plate frame may be noted, and the general compactness of the design. Sheets of any length may be sheared right through the middle. The punches are conveniently held by a coupling nut, and are so operated that the punch can be set for intermittent or continuous work and can be operated either by hand or by treadle. The punch can be placed on the centre mark or it can be allowed to float. The notching device has square blades, and is designed to carry out a wide variety of work. The cropper is placed diagonally at an angle of 45 degrees, an arrangement which permits of bevel cuts on angles and tees being made with the material in the horizontal position.

TURBINE GEARS, LTD.

Gear cutting machine tools made by Turbine Gears, Ltd., of Cheadle Heath, Stockport, a subsidiary company of Henry Simon (Engineering Works), Ltd., of Cheadle Heath, are illustrated in the accompanying engraving. In Figs. 48 on p. 304 and 69 below are shown an automatic bevel gear generating machine. Its design is based on the original Robey-Smith machines but the firm has recently made many improvements and redesigned it so as to comply with modern conditions. It employs a simple and cheap type of cutting tool and can be used for generating a wide range of products.

The principle of operation is that of the shaping machine. Two tools are used, one on each side of the tooth, carried on slides on pivoted arms, which converge on a centre intersecting the apex of the wheel to be cut. The tools move backwards and forwards on the slides on the pivoted arms, the backward movement being accelerated, and at the same time the pivoted arms are gradually opened and closed so that the distance between the cutting tools is varied and a curve cut on the tooth being formed.

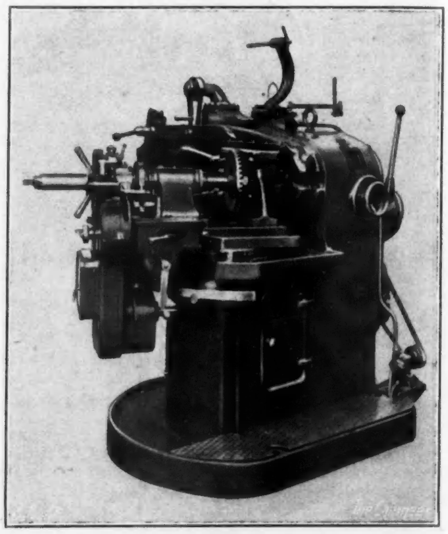

FIG. 69—BEVEL GEAR GENERATOR—TURBINE GEARS

It will be seen by referring to the illustrations that the saddle carrying the blank to be cut is given a rotary motion, the centre being directly under the apex of the blank. This rotary motion of the saddle feeds the blank to the tools and is automatically stopped when the proper depth of tooth has been cut. The saddle is connected with the pivoted arms carrying the slides and cutting tools by a circular bar having teeth cut in a portion of its circumference. These teeth engage in a quadrant, which, through a pair of bevel wheels and a slotted lever operating through an adjustable connecting-rod, controls the movement of the former plate, which in turn controls the opening of the pivoted arms. The blank is rotated the distance of the pitch for each stroke of the tools, thus, it is claimed preventing the local heating common in machines which complete one space at a time, and also eliminating errors due to wear of cutting tools.

An index is provided at all points where adjustment is made so that little skill is demanded of the workman when handling the machine. Particulars are supplied which enable gears to be cut to either 14½ deg. or 20 deg. pressure angles, also of a form on the principle of increasing the addenda of wheels to allow for interference.

The body of the machine is in the form of a rigid box casting designed to resist stresses, and the base is arranged as a trough, covered to form a tank for the cutting lubricant. The pump for circulating the lubricant is mounted in this base. As explained above, the slides carrying the tools are in their turn carried on pivoted arms which open and close as do the blades of a pair of scissors. To remove undue stresses caused by the tendency of these arms to drop a balancing mechanism has been introduced whereby, it is stated, they keep each other in absolute balance, rendering possible much quicker manipulation of these parts when setting the machine, as well as the production of better work.

The saddle is carried on an extension of the body of the machine. It has a radial motion about the geometric centre of the machine and is controlled by a worm and circular rack. On the underside of the saddle is bolted an apron housing the feed and index mechanism, which runs in an oil bath of large capacity. On the upper side of the saddle is bolted the headstock carrying the wheel blank to be cut.

The spindle of the work-holding headstock is large in diameter, and is mounted in long bearings with adjustment for wear. It is bored throughout its length for mandrels and gears with long bosses. The spindle carries a dividing wheel of the ratchet type, by which divisions for the number of teeth are effected. Twenty-one dividing wheels are supplied for dividing all numbers from 10 up to 50; also a range between 51 and 1200. An outer support is provided for carrying the ends of mandrels, rendering, we are informed, the blank steady under all cuts. The tool-boxes are mounted on slides on the pivoted arms on the clapper box principle, as in planing machines, and are designed rigidly to support the tool with a minimum overhang.

Four gauges are supplied with each machine, two for setting the tools and two for setting the blanks in position. The cutting tools are of simple but special shape and are in pairs, a varying number being required for the full range of pitches; these tools are made from a special high-speed steel and their shape accurately ground in jigs to gauges. All settings and movements upon the machines are covered by vernier scales.

Spindles and rotating pins are of high-tensile steel, machined and ground to fine limits, and all sliding surfaces are accurately scraped and bedded. Where these surfaces are of cast iron a close-grained material is used.

All continuous revolving gears or mechanisms run in bronze bushes of ample proportion or ball and roller bearings in the case of high-speed mechanisms. They obtain a continuous supply of oil from a reservoir situated on top of the main body casting; the oil is then cascaded to a lower level through the various mechanisms and returned to reservoir by pump; oil baths are provided with sight glasses.

The drive to the tools is through a quick-return stroke mechanism incorporating a nine-speed gear change entirely enclosed in the back of the main body casting and driven by a friction clutch housed in the particular drive required. The machine is driven either by single pulley from line shaft or by constant-speed motor through V belts with push-button control.

The bevel gear generator described above can be supplied in five standard sizes; the largest machine of this range is designed to cut wheels up to 56in. in diameter.

In Fig. 49 on page 304 we illustrate an automatic worm wheel generator, a machine of the "tangent" feed type, of the original Smith and Coventry design, though much improved by Turbine Gears, Ltd., since they took up its manufacture. It is claimed that, whilst it has ample power for driving hobs when quantities warrant the provision of such expensive tools, it has particular advantages to users who require to cut single wheels or small quantities, and to whom the fly cutter, with its saving in tool costs, is valuable.

Of box shape, the body of the machine is internally ribbed and is very rigid. As in the machine described above, the base of the body forms a trough to retain the cutting lubricant, the pump for which is mounted in the trough. Most of the mechanism is arranged inside the body, and is therefore clear of dirt and cuttings. Removable covers are provided for the inspection of such mechanism.

To support the cutting arbor a heavy bridge piece, spanning the full width of the body, is arranged. It is mounted, the firm states, in such a way that it cannot get out of line, and is movable for adjustment to varying centres. The mechanism driving the cutting arbor is contained within a completely enclosed box rigidly attached to, and sliding with, the bridge piece. Also contained in enclosed boxes are the various gears.

Only one set of change wheels is required. Twenty rates of tangential feed are provided, with a range of about 150 to 1 to cover practically all numbers of teeth and numbers of starts. The feeds are operated by levers moving over graduated dials, and can be started, stopped, changed, and reversed whilst the machine is in motion. Automatic trips are provided in each direction. The index worm is hardened and ground, and the index worm wheel is divided for purposes of adjustment. The working centres are set by direct measurement and provision is made for using gauge rods for centres and pitch diameter of the worm.

The generating mechanism is a direct application of simple geometrical principles, whereby the wheel blank receives an added movement corresponding exactly at the pitch line with the tangential traverse of the hob or fly cutter, without the use of change wheels. Of special form, the cutter arbor is arranged to receive the fly cutter without distortion, for the cutter is secured by a central clamping screw. The arbor runs in adjustable bearings giving a maximum support near the point of cutting.

Single pulley or constant-speed motor drive can be used. The driven member on the machine is in the form of a clutch, which can be quickly released or used for inching purposes when setting up the machine. The drive is connected to a gear-box with six speed changes.

Three standard sizes of machine, with maximum working centres of 12in., 20in., and 30in., are made.

Dowding and Doll, Ltd.

On the stand of Dowding and Doll, Ltd., Greycoat Street, London, S.W.1, would have been a Lester automatic injection moulding machine for plastic materials, and a Lester die casting machine. As may be seen from the illustration of the plastic moulding machine in Fig. 70, the conventional tie bars have been replaced by a heavy steel beam across the top and bottom to form a closed frame. This form of construction prevents vibration and distortion of the machine members during operation and serves to ensure constant accurate alignment of the die. The hydraulic ram which opens and closes the mould has a screwed cylinder mounted on the forward end of its piston, and this cylinder carries the toggle locking plate and the movable die plate. A worm wheel is interposed between the die plate and the cylinder, and this wheel is turned through a worm actuated by a crank handle at the side of the plate. The movement of the die plate on the cylinder, through the worm wheel, enables adjustment of the machine for various thicknesses of moulds. In operation the mould is locked together by a toggle mechanism, the links of which have cam faces on their ends. These cams are adapted to take the entire force of injection off the toggle pins. By this arrangement the toggle pins are used only in the opening and closing movements of the mould and are relieved of strains and wear. Once the mould is closed the force set up by injection is transmitted through the toggle links to the back plate of the machine. The die and toggle plates are guided on substantial square section slideways, the head end of which is formed as a rack. A pinion in the base of the stationary die plate meshes in the slideway rack and is used to move the plate forwards, if required, without endangering the mould.

Material is fed into the mould by an injection plunger actuated by a hydraulic cylinder set over the head of the machine. This injection plunger slides in a hardened and ground, water-cooled, steel bush. The charge is fed from a pressed steel hopper at the back of the head into a sleeve-type heating cylinder, and once the feed has been established it is maintained constant by a self-compensating feeding device. A sleeve-type heating cylinder is used to avoid any loss in injection pressure likely to be incurred when it is required to spread the material after compression has started within the cylinder. Two automatic controls regulate the temperature of the heating cylinder and enable accurate control of the heat of material from the time it enters until it is injected into the mould. The complete feeding, heating, and injection assembly pivots on one of the columns supporting the hydraulic cylinder and can be easily swung clear to permit the removal of any sprues broken off in the mould.

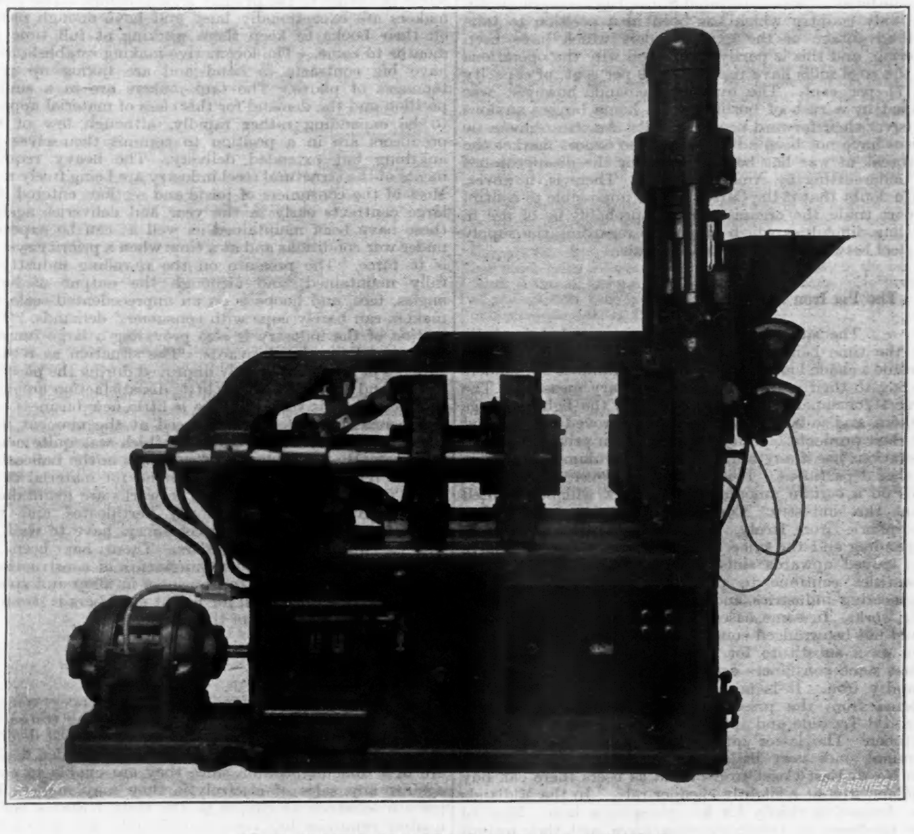

FIG. 70—PLASTIC MOULDING MACHINE—DOWDING

The cycle of the machine is controlled by three time clocks which can be set to maintain a steady output.

(To be continued)

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

ELECTRIC HAND LAMPS FOR AIR RAID PRECAUTIONS

B.S./A.R.P. 3.—This specification is for electric hand lamps (fitted with primary battery or unspillable accumulator) and was prepared at the request of the Air Raid Precautions Department of the Home Office. The specification relates to the design and construction of electric hand lamps for general use out of doors or in buildings in which the windows, roof lights, &c., are not screened. It will be obvious that the ordinary torch type of hand lamp would not be suitable for use in such conditions as no means are provided for preventing the light rays being directed upwards. The specification which has just been issued requires that the design of the hand lamp shall be such that the light emitted is properly directed and screened.

Copies of this specification are priced 3d.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The Steel Cartel and the War

It has always been recognised that the outbreak of a war in which any of the principal members of the European Steel Cartel were involved would bring to an end the existing arrangements. At the moment no one can say whether or not the Cartel will function in a limited degree for so long as it is found possible, or whether the organisation will become moribund. The members of the Cartel were France, Belgium, Luxemburg, Germany, and Great Britain, whilst the United States makers had an arrangement binding the majority of the big firms. The Polish industry was also working in agreement with the Cartel. There is no doubt that in the British and French and neutral countries there is a strong desire amongst the steel-makers to continue the Cartel organisation in some form during the war. Whilst the British and French industries are under Government control, however, it is difficult to see how a suitable arrangement can be reached, even if the Cartel's activities were limited to maintaining some control over the export markets. It is obvious that the German industry has ceased to exist as a factor in the steel trade of the world whilst hostilities continue; on the other hand, the allies' war requirements are likely to be on such a scale that there may be little surplus for export. The French and Belgian works, also, may find that the circumstances of war will make trading with overseas markets difficult, whilst lack of cargo space, increased war risk insurance, and fluctuating exchanges will add to the troubles of this class of business. Since the outbreak of war the United States has been practically the only country which has been in a position to take full advantage of the export orders which have been offering, and this is partly the reason why the operations at the steel mills have risen from 59 per cent. of capacity to 71 per cent. The overseas demand, however, was helped by a rush of business from home buyers anxious to cover their forward needs. Whilst American domestic prices have not been advanced, in the export market the outbreak of war has been followed by the disappearance of undercutting by American firms. There is, however, little doubt that if the Cartel finds it impossible to control export trade, the organisation will probably be of use in settling difficulties which may arise regarding the supply of steel between the allies and neutrals.

The Pig Iron Market

The situation in the pig iron market is static for the time being. The demand for foundry iron has become a shade more active owing to a number of founders adding to their stocks as a precautionary measure. The largest consumers of foundry iron are the light castings makers, and so far the war has not improved the demand for their products. In fact the decline in private building operations has if anything lessened the volume of business in that department. It is possible, however, that as time goes on a certain amount of war work will be required from this industry. Consumers continue to buy low phosphoric iron freely, but although the demand is expanding and the price is uncontrolled quotations have not moved upwards since the outbreak of war. Large quantities continue to pass into consumption in the engineering industries and to many firms engaged upon war work. In some cases in which convenient delivery could not be arranged consumers have turned to hematite iron as a substitute for foundry. On the North East Coast some consumers are receiving supplies of Midland foundry iron. It is not anticipated that prices will be altered from the present level for Cleveland No. 3 of 99*s*. d/d Teesside and 102*s*. d/d Glasgow until the end of October. The latter quotation, however, is practically nominal since very little iron is now transported from the North East Coast to Scotland as users there can buy Midland iron at a slightly cheaper rate. In the Midlands the demand is chiefly for low phosphoric iron. Most of the producers of this description have sold their output for the remainder of the year. The quotation varies from £5 10*s*. 6*d*. to £6. The foundry iron market in Scotland has been moderately busy, and some of the founders have benefited from orders for army canteen equipment. The hematite market in this district has been active for several weeks past and a considerable tonnage is passing into consumption. To a great extent the pig iron industry is concentrating upon the production of basic iron for the steel works from which there is a heavy call.

The North East Coast and Yorkshire

The steel industry on the North East Coast has now settled down to work under the Government control, with very little disturbance. Some adjustments will naturally have to be made to fit the operations of the industry into the control scheme, and no doubt there are some cases in which sacrifices will have to be made by individual firms. Production is being pressed to the utmost, and it seems likely that the recent record outputs will be surpassed. The distribution of finished materials also is proceeding steadily and gives little cause for complaint, although naturally in the present priority system some consumers have to wait for delivery longer than they anticipated. The structural engineers continue to take heavy quantities of joists and sections, and as this industry is likely to be fully employed during the war the request for this class of steel is not expected to diminish. The works producing semi-finished steel have been operating at full capacity for some months and the home output plus substantial quantities of semis which are being received from abroad appear to be adequate. The works in the district producing black and galvanised sheets are maintaining full operations and large quantities of sheets are moving steadily into consumption. There has been some export inquiry which the producers have not found it easy to meet in view of the excessive home demand. There is a steady but increasing movement of steel to the shipyards and the pressure to secure deliveries of boiler plates seems to be strengthening. The tank makers are also busy and provide a good opening for this material. The re-rolling industry is fully employed, and the difficulties experienced a few weeks ago with regard to the stringency in the supply of semis appear to have been overcome and generally speaking consumers are well satisfied. The production of small sections continues at a high rate, but on the other hand the demand is well maintained. The Yorkshire steel industry is working smoothly under wartime conditions. The basic steel-makers are operating at full capacity both on the light and heavy sections of the trade. For the time being practically no orders for ordinary commercial work are being placed, largely because the works are so fully occupied upon material required for national purposes. Business in acid carbon and alloy steels is on a good scale, and this largely consists of work required under the priority arrangements. Orders for special steels are coming forward freely, and consumers frequently find it difficult to place contracts for the delivery wanted.

Scotland and the North

Heavy tonnages of steel are going to structural engineers, the railways, and the shipbuilders, and it is noticeable that the consuming trades are adjusting themselves smoothly to the priority arrangements. The plate-makers are exceptionally busy and have enough orders on their books to keep them working at full time for months to come. The locomotive-making establishments have big contracts in hand and are taking up good tonnages of plates. The tank-makers are in a similar position and the demand for this class of material appears to be expanding rather rapidly, although few of the producers are in a position to commit themselves for anything but extended delivery. The heavy requirements of the structural steel industry are being freely met. Most of the consumers of joists and sections entered into large contracts early in the year and deliveries against these have been maintained as well as can be expected under war conditions and at a time when a priority system is in force. The pressure on the re-rolling industry is fully maintained, and although the output of small angles, tees, and hoops is on an unprecedented scale the makers can barely cope with consumers' demands. This section of the industry is also providing a large tonnage of material for the shipyards. The situation as regards supplies of semis has greatly improved during the past few weeks, and there now seems little dissatisfaction amongst re-rollers on this score. There is little new business of a commercial character being placed at the moment, and the demand for fencing material which was quite active until recently has declined. Conditions in the Lancashire market reflect the increasing demand for material of all kinds for national purposes. The works are maintaining good deliveries against priority certificates and this necessarily means that some consumers have to wait for the execution of their orders. There has been no diminution in the market requirements of constructional steel plates and sheets, and business in alloy and special steels is active. The call for bright steel bars is straining the productive capacity of the works.

Copper and Tin

The demand for electrolytic copper remains strong, but there is little new business being transacted except by the agents of producing firms. Whilst dealings on the London Metal Exchange remain suspended dealers are in a difficult position since they are unable to cover against any sales of electrolytic they may make. The price of electrolytic copper in the United States and in neutral countries has risen considerably and is between £65 and £70; but the official quotation in this country is held at the maximum of £51. In these circumstances it is not every producer who is anxious to sell much of his copper. Although the Metal Exchange is closed so far as dealings in copper are concerned, a certain amount of business has been transacted in the outside market in levelling up positions. On September 12th it was announced on the Exchange that anyone with positions open through having bought standard copper and sold electrolytic against it should make a return to the Secretary of the tonnage of the electro which he had to deliver in Great Britain, allied or neutral countries. A second Order has been issued by the Control of the Non-Ferrous Metal Trades embodying a schedule of maximum prices in which the errors we have referred to in previous issues have been corrected. There was no market for tin between September 12th and 18th. On the former date it was announced that at the request of the Ministry of Supply it would be closed. It was generally understood that the position which had resulted from the rapid advance of prices in the United States and in neutral countries was the reason for the Government's action and that negotiations concerning the regulation of the market are being conducted between the British and United States Governments, the International Tin Committee, and the Buffer Pool. The suggestion is also made that a barter arrangement may be made by which America would exchange refined copper for Empire tin. The International Tin Committee announced last week that it had been decided to increase further the quota for the third quarter from 60 per cent. to 80 per cent. of the standard tonnage, and on September 18th a notice was issued that the quota for the third quarter would be raised to 100 per cent. When the market opened on September 18th it was found that an Order had been published entitled Tin Order No. 1. This established a maximum price of £230 ex United Kingdom producers' works for 99 per cent. to 99·75 per cent. and £231 for tin 99·75 and upwards.

Turkey's Minerals.

In view of the outbreak of war and the relations of Great Britain with Turkey, the "Report on Economic and Commercial Conditions in Turkey" to April, 1939, price 1*s*. 3*d*. net from H.M. Stationery Office, is of interest. Since 1936 the economic and financial situation of Turkey has steadily improved. The Report points out that agriculture must remain the mainstay of the Turkish economic life, and the establishment of an agricultural machinery factory is envisaged. The grant of credits by Russia and Great Britain has had a considerable influence on the import figures, the latter owing to the agreement to enable Turkey to establish an iron and steel works at Karabuk in Anatolia. This was done with the assistance of the Export Credits Guarantee Department, which arranged a credit of three million pounds. It is stated that the iron and steel works are nearing completion and should commence operations in the near future. Turkey is an exporter of a number of ores, and the mining industry would appear to be in a prosperous condition. In the mining companies exploiting or developing mines in Turkey, German capital is behind the Turk Maden Sirketi which works mines having an annual production of 45,000 tons, or approximately 22 per cent. of the total. Of the production of chrome in Turkey 68,463 tons was exported to Germany in 1938 compared with 58,383 tons in the previous year. Sweden took 46,113 tons in 1938 and 45,889 tons in 1937, whilst the quantity sent to Italy jumped from 4,772 tons in 1937 to 32,220 tons in 1938. French purchases from Turkey, however, declined to 14,259 tons last year from 19,898 tons in 1937. The exports to the United States also declined from 45,632 tons in 1937 to 13,384 tons last year. The British share rose from 1016 tons in 1937 to 3656 tons in 1938. The whole of the Turkish exports of copper went to the United States, the total rising to 1965 tons last year from 400 tons in 1937. The total export of lead reached 6603 tons in 1938 compared with 8393 tons in 1937. Last year Belgium took 2438 tons and France 2133 tons. In 1938 the exports of antimony amounted to 1148 tons against 1399 tons in the previous year. Japan took 847 tons in 1938 compared with 51 tons in 1937, whilst Great Britain received 129 tons last year against 1142 tons in 1937. Germany took 41 tons in 1938 and 206 tons in 1937. Apparently the whole of the exports in 1938 of zinc (blende and galena) went to France, the total being 26,019 tons.

EVACUATION ARRANGEMENTS OF THE UNIVERSITY OF LONDON.—Arrangements have been made to evacuate the whole of the University of London to various parts of the country, and it is hoped to begin the new term early in October. An attempt has been made wherever possible to move the whole of each college to its new home, and other universities have co-operated with London in completing its arrangements. University College is the only one which has been unable to find accommodation for the whole of its students in one place. The men are going to the University of Wales, Aberystwyth. King's College—which has decided to discontinue its courses in Spanish, journalism, psychology and chemical engineering, and its evening classes—is going to Bristol. The Imperial College of Science and Technology is going to Edinburgh and the Mining Department is moving to Camborne, Cornwall.

BRITISH STANDARDS INSTITUTION.—We print below a list of British Standard Specifications relating to various Forms of Civil Defence. The reference letters BS/ARP precede each number.

1. Aggregates for Concrete Shelters Constructed in Situ.
2. Bituminous Paint and Bituminous Compound for the Protection of Steelwork.
3. Electric Hand-lamps (Fitted with primary battery or unspillable accumulator).
4. Apparatus for Decontamination of Oilskin Clothing.
5. Chemical Closets for Use in Shelter Accommodation.
6. Shelter Lighting (Shelters for 50 persons (210 sq. ft.) or multiples thereof up to 200 persons).
9. Gas Proof Cloth for Rendering Windows Gas Proof and Weatherproof after Breakage.
10. Rubber Gaskets for Rendering Doors and Windows Gas Tight.
11. Adhesive Tape for Fixing Gas Proof Material, Repairing Damaged Material, or Sealing Apertures and Cracks, etc.
12. Petroleum Jelly for Sealing Gas-Tight Doors, etc.
14. Black Blind Material for Obscuring Windows.
15. Light Traps for Shops.
16. Specific Methods of Providing Even Illumination of Low Intensity (0·002).
20. Specific Methods of Providing Even Illumination of Low Intensity (0·02).
22. Mixture for Anti-Gas Cloth.

Copies of all the above Specifications are available from the offices of the British Standards Institution, 28, Victoria Street, London, S.W.1, price 3d. post free.

The following Specifications are in course of preparation and will shortly be published :—

Electric Lighting of Control and Report Centres.
Wire Netting for Protection against Flying Glass from Roof Lights and Windows.
Blanket Felt for Rendering Doors and Windows Gas Proof and Forming Gas Locks.
Electric Lighting of Air Raid Shelters (large).
Fluorescent Paints.
Adjustable Hinges.
Specific Methods of Providing Even Illumination of Low Intensity (0·2).
Blind and Curtain Material (Textile).

French Engineering Notes

(From our own Correspondent in Paris)

Public Works

WHEN the general mobilisation was declared all work on public undertakings in the Department of the Seine had necessarily to be suspended. They include the sewerage works which are to carry sewage from the Department to the farm at Achères, as well as improvements to the Paris water supply, and the widening and reconstruction of bridges across the Seine, in order to deal with the heavily increased traffic on the wider roads radiating from Paris. Work on these and other undertakings had been slowed down in consequence of the Labour Political Movement that had disorganised the country for more than two years. When, therefore, the new Government reacted successfully against this movement, and supplied funds for a continuance of the works, renewed activity seemed likely to make up for lost time. As a means of enabling these enterprises to be carried on during the war, the Minister of Public Works has appointed a committee of four members representing the military authorities, the Minister of National Education, the Chief Engineer of the Ponts et Chaussées for the Department of the Seine, and the General Director of Paris Works. After doing what is necessary to ensure the urgent execution of works of direct military importance, the committee will co-ordinate public and private undertakings in order to make the best use of the men and material available. The military authorities will necessarily have the right of requisitioning what is absolutely necessary for the conduct of the war, but beyond that limitation men and material, lorries and the like, employed by public works' contractors and builders in the Department of the Seine, cannot be requisitioned without the committee's approval. By this means it will be possible for contractors and builders to carry on their business without interference if the committee finds that the needs of the Army can be met elsewhere. Requisition in the Department of the Seine is no longer indiscriminate, but must conform to recommendations offering the least inconvenience to the public works and building trades.

Demand for Engineers

All engineers of military age are, in a general way, being appointed to duties for which their training specially qualifies them, either on active service, or in works where their presence is indispensible. The Ecole Polytechnique was founded by the first Napoleon to provide artillery engineers, and it has always preserved this character, although only a small proportion of students take to the Army as a career. Others seek administrative posts and positions of responsibility, and the prestige attached to the Polytechnique ensures a preference for them, other things being equal. The Ecole Centrale has not the same prestige as the Polytechnique with its semi-military character. Engineers from the Centrale, or Ecole des Arts et Métiers, as it is officially known, are trained for industry, and the special character of their moral, technical, and scientific training places them in a class apart. In time of war these two schools provide men of initiative, skill, and responsibility for all the services, as officers at the front and for organisation of production and supplies at the rear. While engineers from the Arts et Métiers and other schools and universities are absorbed by the war there are relatively few left to carry on private industry, and it has become a matter of primary importance in a war which depends largely upon economic pressure to make sure that there is an adequate supply of engineers. Many engineers debarred by age or for other reasons from working under normal conditions of pressure may be capable of rendering useful service in this time of emergency. The Fédération Nationale des Syndicats D'Ingénieurs Francais appeals to these and other engineers without employment to send in their names, which will be communicated to the Minister of Labour. Upon the response to this appeal depends largely the success of the Minister's efforts to organise private industry by making the best use of all available workers, who will be distributed where required amongst employers engaged in production independently of war requirements.

Civil Defence

Arrangements for civil defence in France are similar to those in England, although differing in methods and allowing, at first, plenty of initiative to public authorities and others in carrying out plans for the protection of those for whom they are responsible in the event of air raids. These plans were prepared long ago and were made known to the public by decrees which have force of law, but the decrees can be modified by others, and the arrangements left finally to settle down to a form that fits in with the financial possibilities of the State and those public bodies that are expected to make as large a contribution as possible to the cost. Consequently, the work is at first of a somewhat tentative character and is relatively slow. When, however, the critical moment approaches, the State organisation is ready to accelerate work which is co-ordinated and carried through rapidly. In Paris, covered trenches have been made wherever possible in parks, gardens, and squares. In suburban areas, trenches are being constructed everywhere. No real effort has been made to encourage the use of individual shelters, which are made by a few makers. The production of these shelters would be wholly insufficient to meet any considerable demand for them. Apart from trenches, most attention is given to cellars that are required to be strengthened, and the official belief in the efficacy of cellars is shown by the fact that in future the construction of new buildings will not be authorised until after approval of plans showing that adequate provision is made for protection against air raids. As the Paris Metropolitan Railway is for the most part near the surface, it has only been possible to open a certain number of stations for shelter at sufficient depths. With the reduced population in Paris, there is shelter for everyone, and the authorities take care that there shall be no laxity in conforming to the regulations and that every individual shall be ready for any emergency, to the extent that instructions have been given to the police to summon anyone on the streets of Paris who does not carry his or her gas mask.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application ; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED WATER HEATERS

510,723. February 5th, 1938.—CONDENSERS AND FEED WATER HEATERS, Ernest Stephen Robbins, Greythorp, Risley, Derbyshire.

This invention relates to a process and apparatus for condensing steam employing air or gas as a cooling or condensing medium and has for object to economise in the consumption of fuel for steam generation by conserving and utilising heat extracted from exhaust steam. This is attained by compressing the air or gas, after serving as a cooling medium, so as to raise the temperature, and then using it as a heating medium. The heated air may be utilised in a boiler feed water heater. The invention also includes a steam condenser, in which air or gas serving as a cooling medium is circulated through the condenser in contact with the steam passages in a direction opposite to the direction of flow of the steam. A suitable steam condenser is described and the arrangement of a plant is diametrically described in the accompanying drawing. In this arrangement the air withdrawn from the condenser A passes to an air compressor B which increases the temperature of the air. The compressed air is then conveyed by way of pipe C to a feed water heater D. In this manner considerable saving may be effected in the consumption of fuel for heating the water for steam generation. If desired, the air after leaving the feed water heater may be again compressed so as again to raise the temperature of the air, and the re-heated air may then again be employed in another feed water heater, or for other purposes. Subsequent to utilising the air as a heating medium it may be expanded in a suitable engine indicated at E so as to lower the temperature to a degree sufficient for enabling it to be again circulated by a fan F through the condenser and utilised as a cooling fluid. It will thus be appreciated that the air may be alternately employed as a cooling or condensing and a heating medium, and the cycle of operations may be repeatedly carried out.—*August 8th*, 1939.

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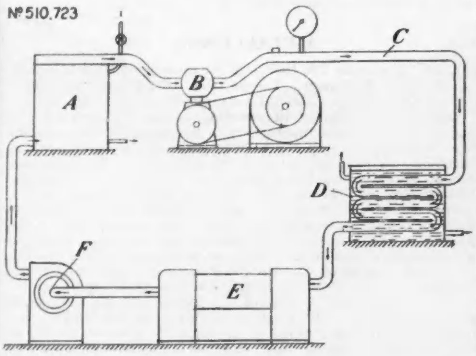

LOCOMOTIVES

510,494. November 11th, 1938.—RAIL VEHICLES, Maybach-Motorenbau Gesellschaft mit beschränkter Haftung, Friedrichshafen on the Bodensee, Germany.

In view of the high speeds required from modern motor rail vehicles the driving mechanism is necessarily large in order to produce and transmit the required power, but the dimensions of the under-carriage and the space available for housing this mechanism are very small, so that difficulties thus arise. By the arrangement of the transmission mechanism parts according to the invention, a particularly favourable and simple mode of construction is claimed. A construction according to the invention is shown diagrammatically in the accompanying drawing. A and B denote two driving axles of a rail vehicle, between which is situated the internal combustion engine C. Connected to the internal combustion engine is a change-speed gear. Following the reversing gear is the differential gear E. The torque passes from the differential gear via the double-angle-drive gear F, connected to universal joints, and via the cardan shafts GG and the axle gears HH in known manner to the driving axles.—*August 2nd*, 1939.

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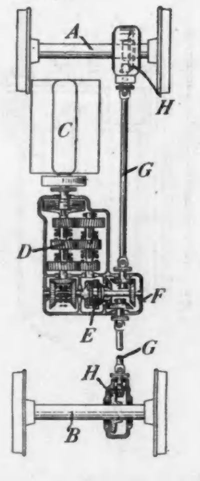

SHIPS AND BOATS

510,447. February 1st, 1938. SUCTION DREDGERS, L. Smit & Zoon's Scheeps-en Werktuigbouw N.V., Kinderdijk, The Netherlands.

In suction dredgers having a suction tube which consists of parts elastically connected with each other ; the tube parts are substantially in alignment and are connected with the suction conduit of the pump and with each other by elastic, but relatively rigid couplings. These couplings give the suction tube a small flexibility but cannot prevent large forces being exerted upon the connecting parts, particularly on the connection between the suction tube and the suction conduit of the pump lying inboard, whereby these connections are subjected to damage during working in relatively rough water. With a relatively strong sea running, dredger operations must therefore be discontinued. The object of the invention is to avoid these disadvantages. The accompanying drawing shows an embodiment of the invention. The suction tube consists of the parts A and B connected together by a flexible tubular member C as well as of an elbow D which is connected at one end with A by a flexible tubular member E and at the other end with the suction side of the pump. When the operation is discontinued the suction tube is raised above the water surface by tackles FF. Cables GG counter-balance the suction tube in such a manner that the suction head rests upon the bottom with approximately unvarying pressure even when a sea is running. To this end the cables are led over pulleys on the ends of piston rods, which can move in hydraulic cylinders, HH. As a result of this, the tension in the cables has the same value in any position of the suction tube. The forces exerted by the parts of the tube upon each other are transmitted through a joint J. The reaction in the support is taken up by chains LL. An elbow M is rigidly connected with the tubular part B and corresponds to the angle between the two parts of the suction tube so that the flexible tubular member C can be straight in the normal position. Obviously both of the tube parts could be provided each with an elbow which together would correspond to the desired angle. The production of torque in the joints and in the flexible tubular members is avoided as far as possible since the upper end of the part A can turn in a rigid tubular member N carrying the support K. By providing for the suction head a tubular member which leads the water from above downwardly to the suction head, failure of the pump as a result of too steep an inclination of the suction tube part B can be prevented in the known manner.—*August 1st*, 1939.

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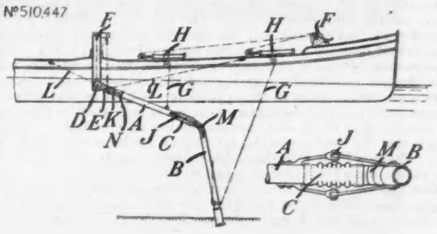

LIGHTING AND HEATING

510,539. February 2nd, 1938.—ELECTRIC LAMPS, Johan Buser, of 122, Fasanenstrasse, Basel, Switzerland.

In the closed glass envelope of the lamp described in this specification, are mounted two different lighting bodies, of which one is a metallic vapour tube as for instance a mercury vapour or a sodium vapour tube, and the other a glow filament A arranged outside the tube B. The glow filament A lies within a space bounded by two parallel planes which pass through the end points of the length of the light tube B and are transverse to the axis of the latter. Good mixing of the light from the two bodies is thereby obtained at the source. C and D are the main electrodes and E is a resistance connected in series with an igniting electrode of the tube B. Instead of one glow filament, in certain circumstances two or even more than two glow filaments could be provided.—*August 2nd*, 1939.

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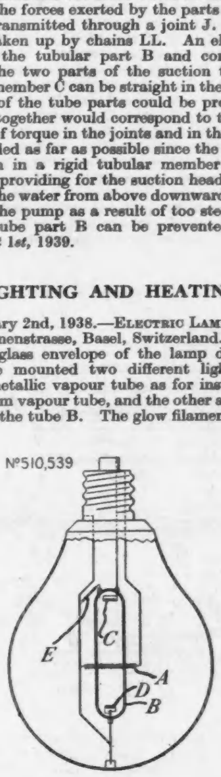

510,458. February 3rd, 1938.—ELECTRIC INCANDESCENT LAMPS, Ilse Barasch, of 29, Longley Road, Harrow, Middlesex.

The object of this invention is to make tubular electric incandescent lamps with only one working cap, at the same time providing means at the lamp itself for supporting the lamp and keeping it in position. The lower drawing shows a tubular incandescent lamp with the actual contact cap A provided at one end of the lamp envelope ; this cap carries both the contacts B and C to which the leading-in wires are connected. In a

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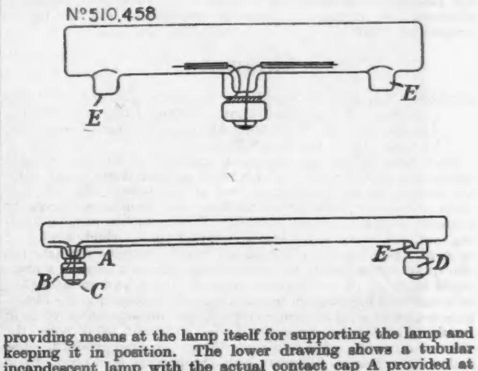

corresponding position near the other end of the lamp a similarly shaped "dummy" cap D is rigidly affixed, by sealing, to the envelope of the lamp. The "dummy" cap may be mounted over a sealing-off nipple of the lamp. This "dummy" cap serves as an additional support for the lamp and may consist of insulating material, *e.g.* synthetic resin, throughout. When the lamp is used in a changeable sign, a lampholder which itself is alive, may receive the "dummy" cap when the lamp is in one position, whereas the same lampholder may receive an actual working cap of a lamp when the lamps are arranged in different positions. The upper illustration shows a tubular incandescent lamp with a working cap situated at the middle of the lamp. Near each end of the lamp envelope is provided a supporting member E which may consist of resilient material, such as rubber.—*August 2nd*, 1939.

510,384. August 9th, 1938.—Capping of Electric Incandescent Lamps, Discharge Tubes, etc., Vereinigte Glühlampen und Elektrizitäts Aktiengesellschaft, of Ujpest, near Budapest.

According to this invention the capping of electric incandescent lamps and like vessels is carried out by previously pressing a pulverulent cement to a shape suitable for introduction into the metal cap, an opening or openings being left in the pressed mass of cement for the passage of the current conductors, inserting the mass of cement in the cap, applying the cap, in the usual manner, to the corresponding part of the bulb and then heating the cap until the cement melts and forms a compact mass, which upon cooling and setting, unites the cap to the bulb. It has been found that in this way the danger of harmful arcing and consequent damage to the cap can be avoided completely. The explanation of this is that cap cements as used heretofore contain alcohol, as a binding agent, and the alcohol evaporates out during capping, owing to the application of heat in that process. Consequently, a porous spongy texture is imparted to the mass of cement and the hollow spaces enable any metallic vapours which may be evolved in the interior of the lamp cap when the fuse (which is built into the outer current supply wire) blows to get at the metal cap and give rise to severe arcing. The result is that the material of the cap melts. Examples of cementitious materials suitable for carrying out the invention are natural and artificial resins with fillers.—*August 9th*, 1939.

BUILDING

510,749. May 7th, 1938.—Improvements in Concrete Floors, Ceilings, etc., Formeta-Beton A/S, Vestre Boulevard 4, Copenhagen, Denmark, and Jorgen Brandt, of Hoeghamindeparken, 2, Hellerup, Denmark.

The invention relates to a building unit for use in the construction of moulded concrete floors and the like, and particularly relates to that type of unit which is left in position in the finished floor and composed of a series of forms arranged on a flat base which in the cast construction serves as a carrier for plaster or the like. The unit comprises a number of boards A, which constitute the base, spaced slightly and interconnected by means of a number of laths B. Boards C of plywood are arranged between the laths in such a manner that they form arches, being sprung into position between the laths. The desired number of complete building units is placed in position prior to the casting of the concrete floor, and are carried by supporting beams, not illustrated. Reinforcements rods D are arranged between the plywood arches, and are anchored to the walls. After this the concrete E is cast on the units. In order to provide a secure connection between the concrete and the building units anchor bolts F mounted in the laths may be provided as shown. The lower portions of the building units act as a support for reeds on to which the plaster G is applied. In the construction of a concrete floor and ceiling as illustrated in Fig. 4, throughout the length of each lath there are spaced a number of anchor members. Each anchor is provided with a flat head H which is disposed between two insulation discs J arranged in recesses in the board and the laths. The anchor is displaceably disposed in a hole in the laths, and after the units are in position on the supports, the laths are covered with insulating strips K.

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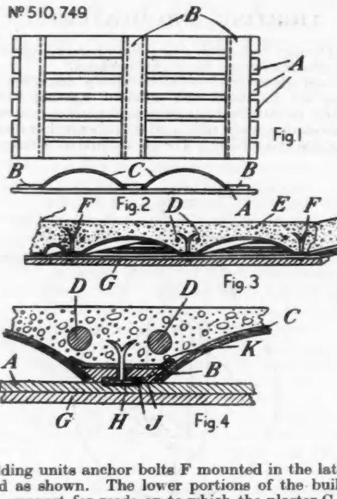

When the concrete is cast in the mould, the weight of the concrete will to some extent compress the insulation strips, and when after the hardening of the concrete the supporting means are removed, the compressed insulation strips will tend to expand somewhat, thereby pressing the boards, laths and plywood downwardly to be disconnected from the concrete and be suspended by the anchoring members only. In this manner the only connection between the unit and the concrete is through the yieldable and insulating material, and there is accordingly obtained an insulation between the floor and ceiling.—*August 8th*, 1939.

HIGHWAYS

510,569. May 13th, 1938.—Road Making or Surfacing Compositions, Woodall-Duckham (1920), Ltd., and Edwin Arnold, both of Ebury and Allington Houses, 136 to 150, Victoria Street, London, S.W.1.

According to the invention, a process for coating mineral aggregates with tarry or bituminous binding materials, especially for the production of road-making or road-surfacing compositions, consists in adding simultaneously to the mineral aggregate a quantity of an aqueous emulsion of tarry or bituminous binding material, and a water-insoluble liquid agent (which is referred to as a "breaking agent") compatible with the binding material, the quantity of breaking agent being such as to cause a more rapid breaking of the emulsion after addition, and agitating the mixture until breakage of the emulsion takes place and the aggregate is coated with binding material, the combined quantities of emulsion and breaking agent being sufficient to provide the desired amount of binding material in the final product. The following examples illustrate how the process is carried out in practice. "Dry tar" as referred to may be either a tar which has been freed from water by settlement, or dehydrated tar obtained by passing crude tar through a steam-heated evaporator.

Example 1:—A mechanical mixing apparatus was charged with 2 cwt. of dry graded granite. 0·25 gallon of breaking agent (consisting of 0·1 gallon of tar middle oil and 0·15 gallon of dehydrated tar) and 1¼ gallon of tar emulsion (containing 70 per cent. by weight of tar, the tar having a viscosity of approximately 3000 seconds at 30 deg. Cent., measured in the British Road Tar Association viscometer) were added simultaneously, or nearly so, to the aggregate. When the binder had become distributed over the aggregate, 6 lb. of cement were added and mixing was continued until a black plastic product was obtained.

Example 2:—A dry limestone was employed, the size ranging from 1¼in.–1in. The mixer was a "macadam mixer" of the revolving paddle type with an overhead charging hopper. From the hopper, 6 cwt. of stone were charged into the mixer. One gallon of dry coke-oven tar as breaking agent and 2 gallons of a 65 per cent. emulsion of road tar were added simultaneously followed immediately by 18 lb. of cement (as a variant 18 lb. of limestone dust was used in another batch). Complete coating of the aggregate and breaking of the emulsion was obtained in less than one minute and the mixer was then emptied. By the method of this Example, 6 cwt. of limestone of size ⅜in. were coated by use of 1½ gallon of breaking agent, 4 gallons of emulsion and 18 lb. of filler.

It will be noted that in the examples the quantity of breaking agent is always less than the quantity of emulsion. In general it may be stated that the quantity of breaking agent employed varies between 10 and 75 per cent. of the volume of the emulsion. Emulsions of either the quick- or slow-breaking type can be used in the process of the present invention. One advantage is that the simultaneous addition of the breaking agent and the emulsion to the aggregate enables coating of the aggregate to be effected in cases in which, owing to the nature of the aggregate or the type of mixing apparatus employed, a good coating cannot be obtained if the breaking agent and emulsion are incorporated separately. The process can be carried out in the cold and the aggregate is rapidly and completely coated with the binding agent, the quality of the coating being similar to that obtained by coating the aggregate with hot tar or bitumen by means of known processes.—*August 3rd*, 1939.

METALLURGY

511,105. *September 7th*, 1938.—Manufacturing High Quality Steel, Bochumer Verein für Gusstahl-Fabrikation Aktiengesellschaft, 64, Alleestrasse, Bochum, Germany.

Steel to be produced in accordance with the invention is smelted in the usual manner in a Siemens-Martin or in an electric furnace, and is carefully deoxidised. It is then transferred into a device, similar to the well-known coreless induction stoves, the wall of the lining of which is kept as thin as possible. The primary coil is provided with an efficient water cooling system. An alternating current of small energy and low frequency (preferably of 50 periods) is then passed through the primary coil. The energy should be so regulated that the temperature does not rise, the heat produced by the current being just carried off by the water cooling system of the coil. The low frequency results, even in the case of a small wattage, in the electrical energy penetrating deeply, and the bath being slightly agitated. The steel is subjected to the same energy until sufficient opportunity of separating has been afforded to the impurities such as sand, slag, etc., and to the gases and oxides. The slight agitation of the bath prevents the occurrence of differences of temperature and ensures that the bath becomes thoroughly homogeneous. The steel is allowed to solidify in the electrical device. For this purpose, the supply of energy to the primary coil is reduced, and the bath prepared for solidification. In view of the withdrawal of heat through the water cooling system, the first crystals form at the wall. Obnoxious (columnar) crystals cannot, however, form in view of the peculiarity of alternating currents in acting more energetically on solid, magnetic materials, and concentrating at the edges of the bath, and in view of the agitation of the bath. Separating phenomena and reactions causing the release of gases and the formation of liquation spots characteristic of large ingots are also prevented. The bath is then allowed to solidify uniformly by cooling it below the melting point. By adjusting the supply of energy, it is possible to maintain the most favourable cooling conditions after the solidification of the ingot.—*August 14th*, 1939.

MISCELLANEOUS

510,817. *March 15th*, 1938.—Improvements in Filters, Stream-Line Filters Limited, and Albert Beale, both of Hele-Shaw Works, Ingate Place, Battersea, London, S.W.8.

This invention is an improvement upon oil filtering apparatus of the kind wherein an air pressure set up in part of the apparatus during normal filtration is utilised upon stoppage of an engine and pump to operate in reverse direction to the normal flow of oil and force accumulated solids from the filter elements. In the arrangement illustrated a filter vessel encloses a number of filtering devices A of any suitable known type but preferably consist each of an assembly of annular disc filter elements enclosing a tubular passage B. The oil discharged from the upper ends of the passages enters a chamber C which, in the example illustrated, is superimposed upon the cover D of the filter vessel. The oil can only leave this chamber to return to the engine sump by way of a pipe E provided with an outlet valve F in a valve housing mounted in one side of the chamber. The outlet valve is mounted on a stem surrounded by a spring which holds it on to its seating, the outer end of the spring abutting against a plug G having an outlet port and being threaded in the wall of the valve housing so that by screwing the plug in or out it is possible to vary the compression of the spring. The oil passing through the port leaves the valve housing through an outlet which is connected with the engine sump. The arrangement of the valve F causes it to offer a certain amount of back pressure which in conjunction with the fact that the outlet pipe E leads from a point near the bottom of the chamber causes an air lock to be formed in the chamber when the apparatus is functioning in the normal way, while the engine and pump are running. When operation ceases the pressure on the oil inlet side falls and the air cushion which has been formed in the chamber will expand forcing oil back through the passages and filter packs to remove accumulated solids from the exterior of packs. In order to prevent this sludge in the base of the filter chamber from being stirred up by the flow of fresh oil into the chamber, oil to be treated is introduced without commotion at or near the upper end of the filter vessel. This is done by admitting the oil through a pipe J to an annular passage K formed around the exterior of a flange which depends from the under side of the cover and is of such dimensions as to leave a narrow passage between its outer surface and the wall of the filter vessel. With this arrangement the incoming oil enters the filter vessel around its wall in the form of an annular film. In order to prevent the flow of oil through the filter vessel from being impeded at the commencement of operations by the relatively high viscosity of any body of cold oil retained in the vessel, a small jet L in the cover works in parallel with the filter devices and allows a flow of unfiltered oil to take place through the filter vessel with sufficient rapidity to ensure that incoming hot oil will quickly fill the vessel. The jet is sufficiently small to restrict the rate of flow of oil so that it is not detrimental to the engine. Immediately below the jet a non-return valve is provided to prevent loss of air pressure in the upper chamber when the engine stops running. To prevent the jet becoming choked with solid matter contained in suspension in the oil a fine gauze strainer is fitted over the lower end of a pipe M which supplies the jet. As in most cases it is important to heat the oil for filtration the pipe J through which the oil reaches the filter vessel may be connected to a heating coil fixed around the exterior of the engine exhaust manifold. The filter above described is so arranged that it draws dirty oil directly from the pressure side of an engine oil circulating pump through the pipe J and returns the filtered oil through a pipe connected to the outlet H to the engine sump at atmospheric pressure. The air pressure which is built up during the filtering operations in the vessel C causes accumulated solids to be automatically removed from the filter devices whenever the engine and pump cease to operate.—*August 9th*, 1939.

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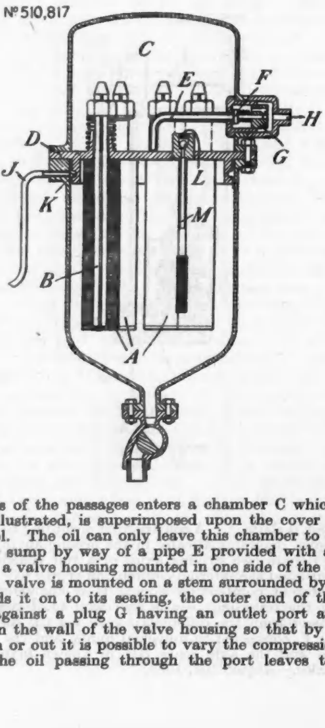

510,592. November 3rd, 1937.—Light Responsive Cells, Radioaktiengesellschaft D. S. Loewe, of 10, Wiesenweg, Berlin-Steglitz, Germany.

The light responsive cell described in this specification is of substantially cylindrical or spherical form and contains a photoelectric cathode A on which the light impinges as indicated by arrows, two secondary emitting nets B and C, and a further permeable electrode D. The latter electrode acts as terminal anode. The electrode E is an impermeable rod or tube activated for secondary electron emission. In operation the electrodes B, C, and D are supplied with increasing positive potentials with respect to the cathode A. The potential of E is a little lower than that of D. The electron steam emitted by A is accelerated by the increasing potentials at B, C, and D and at the same time multiplied by means of the secondary emitting nets B and C.

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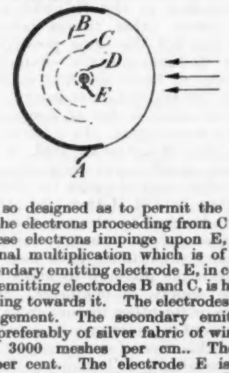

The anode D is so designed as to permit the passage of substantially all of the electrons proceeding from C in the direction towards E. These electrons impinge upon E, and there now occurs an aditional multiplication which is of particular efficiency as the secondary emitting electrode E, in contradistinction to the secondary emitting electrodes B and C, is hit by practically all electrons moving towards it. The electrodes are mounted in concentric arrangement. The secondary emitting electrodes B and C consist preferably of silver fabric of wire of 40 microns thickness, with 3000 meshes per cm.. The transparency amounts to 70 per cent. The electrode E is a silver tube 15 mm. in length and 2·2 mm. in diameter. The electrode D is a spiral of large pitch, the lead to which is passed out of the tube separately from the remaining leads in order to obtain a low capacity (about 3 cm.) towards the cathode A.—*August 3rd*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Railway Club

Thursday, October 5th. Royal Scottish Corporation Hall, Fetter Lane, E.C.4. "The Story of Bradshaw," Canon R. B. Fellows. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

Sharples Centrifuges, Ltd., have transferred their offices and staff to "Hill Grove," Rooksmoor, Woodchester, nr. Stroud, Glos.

Wild-Barfield Electric Furnaces, Ltd., have transferred their offices to a temporary address at 2–6, Highwood Avenue, Bushey, Herts.

Bull Motors, Ltd., Ipswich, ask us to say that in London, Manchester and Glasgow their Branch offices are remaining open at the usual addresses, and private addresses and telephone numbers of Branch Office Managers have been issued to all customers. Engineer representatives are also available in Birmingham and Sheffield to provide technical service facilities in Yorkshire and the Midlands.

Siemens-Schuckert (Great Britain), Ltd., inform us that consequent on the outbreak of war the Company has severed all connection with Germany, and is now entirely under British direction. The Chairman of the Board of Directors is Mr. Henry Morgan, F.F.A.A., who is also Chairman of the London Chamber of Commerce. Mr. A. White has joined the Board, and has been appointed Managing Director *pro tem* in order to effect the necessary measures of re-organisation. It is proposed to extend the manufacturing programme to cover a number of products previously supplied from Germany.